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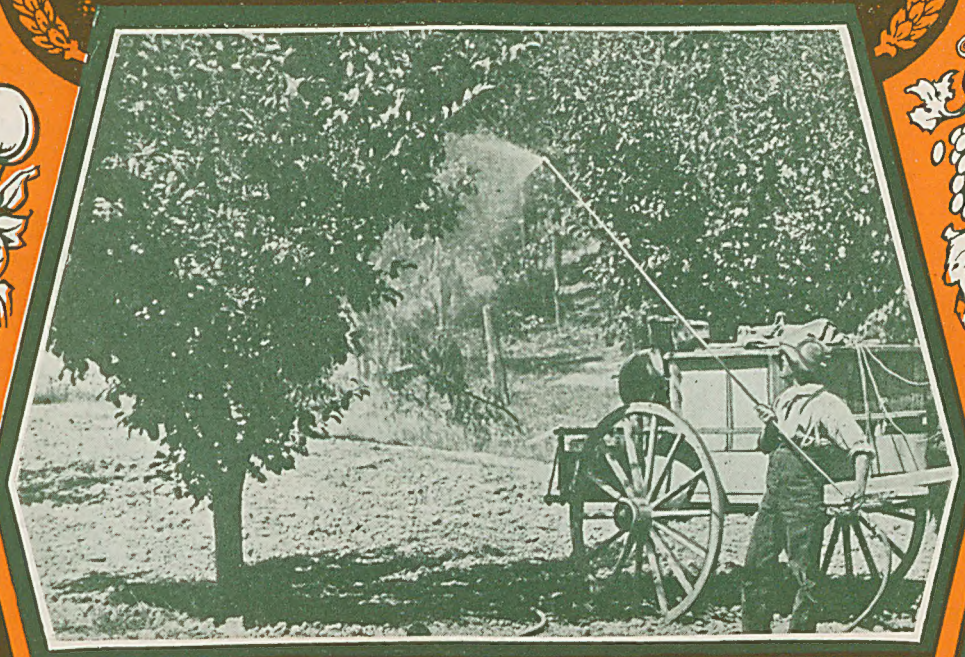
VOL. XXX. PART 11

The JOURNAL of AGRICULTURE

Of The Department

VICTORIA AUSTRALIA



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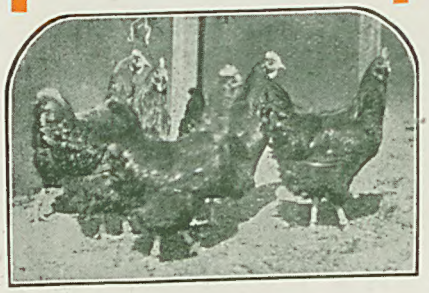

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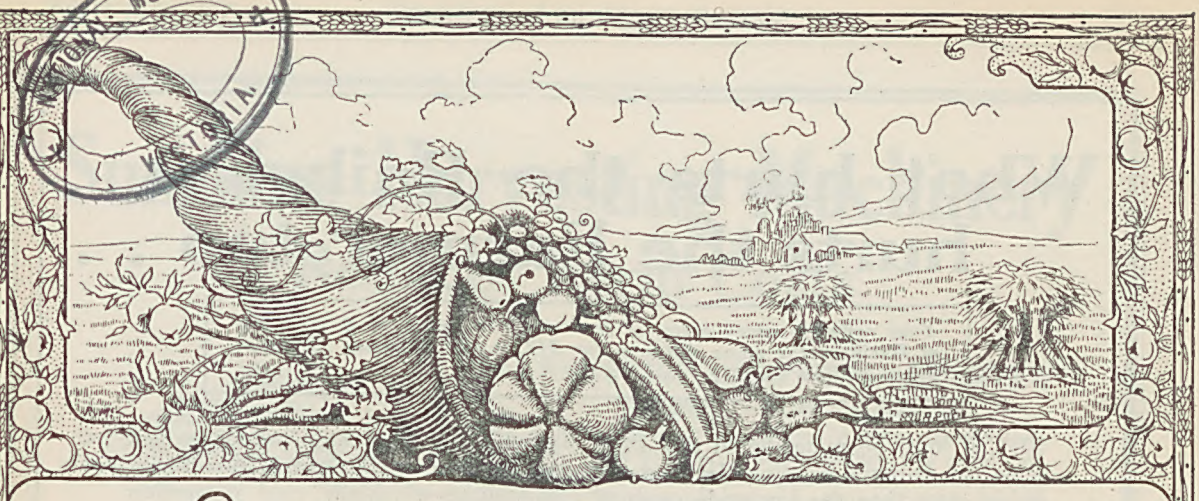

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Issued under the direction of the Hon. J. Allan, M.L.A., Minister of Agriculture.

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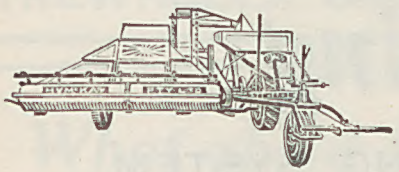

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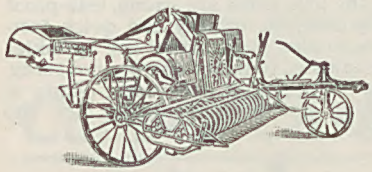

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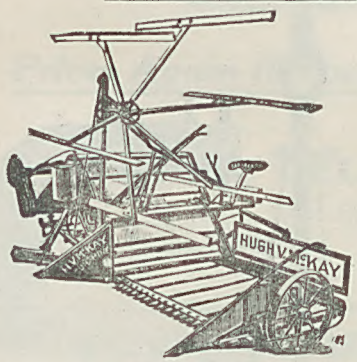

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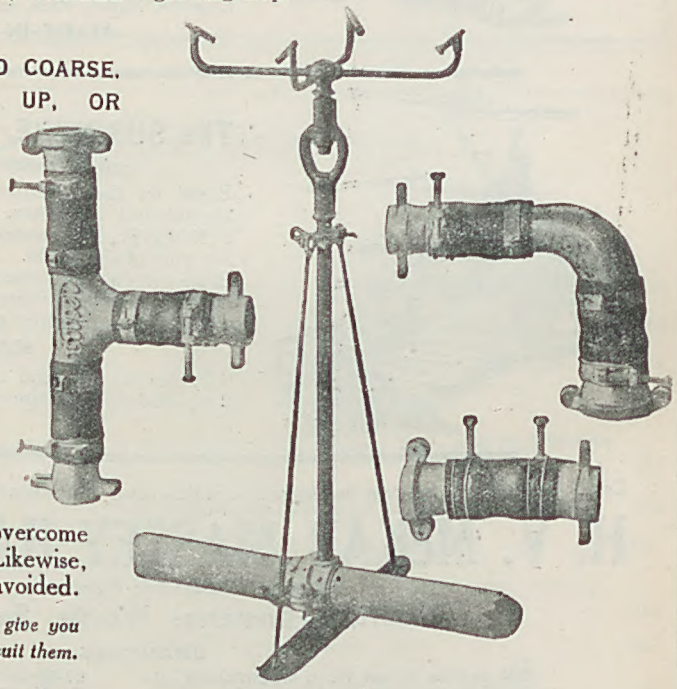

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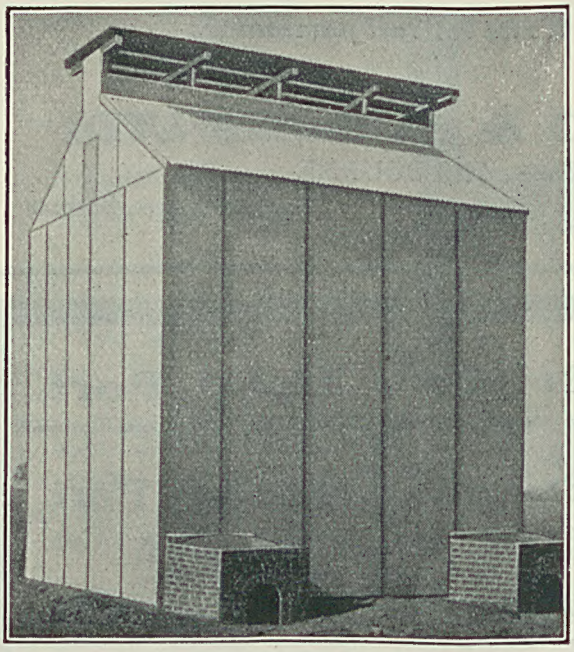

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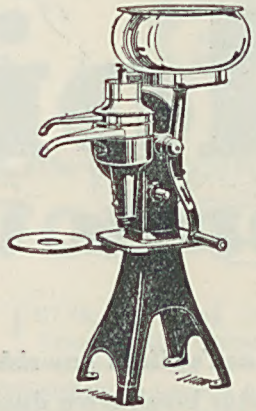

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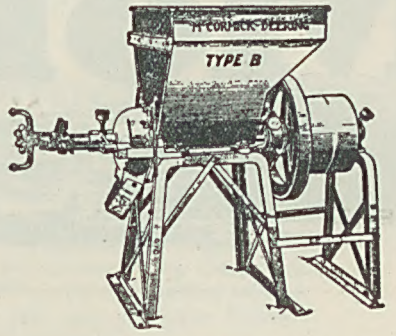

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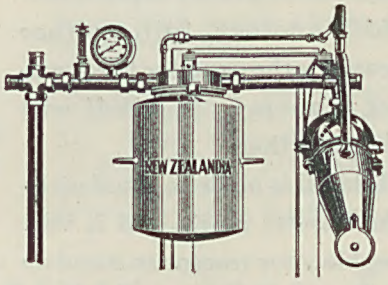

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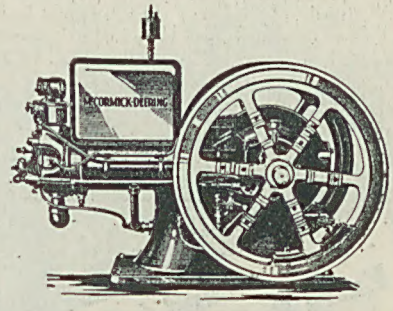

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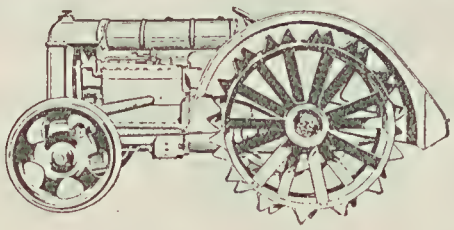

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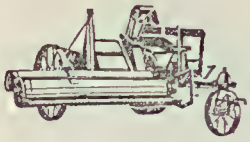

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The Journal of the DEPARTMENT of AGRICULTURE of VICTORIA

Pasture Plant Research

Work at Burnley

By J. E. Harrison, B.Agr. Sc., Senior Agrostologist.

PASTURE plant research at Burnley was undertaken with the primary object of making strain investigations of various pasture plants. Similar work in other countries has shown that definite strains or varieties of plants exist, and that each may exhibit adaptation to a particular set of climatic and soil conditions. The aim at Burnley is to separate the principal pasture plants of the State into strains and, by field tests, to discover those which are most suited to the various districts.

The extension work carried out by the Agrostology Branch as a natural adjunct to this detailed study of pasture plants consists of field trials in the various districts, lectures to farmers, and personal contact with individual farmers on their own farms, or with those who may visit the Branch to inspect the work. The Agrostology Branch is invested also with the duties of seed testing, a necessary service in any progressive agricultural community.

The field work began with strain investigation of subterranean clover in the autumn of 1928. In the same year the Wimmera ryegrass selections were transferred to Burnley from the State Experimental Farm at Rutherglen.

In 1929 some 150 lines of subterranean clover seed, collected from numerous sources, were sown and subjected to a critical examination. The Wimmera ryegrass selections were grown on, and special attention was given to a study of the need for cross pollination by this plant. Strain investigation was begun on a small scale also with ryegrass, cocksfoot, and white clover. In addition, a grass museum was established for educational purposes.

The year 1930 saw a continuous and elaboration of these activities, especially in regard to subterranean clover and Wimmera ryegrass. In the following year, 1931, the Agrostology Branch was officially formed as a unit of the Agricultural Division of the Department of Agriculture. There was a continuation of the work of the previous years, with a considerable extension of the work of investigating strain in perennial ryegrass, about an acre of land being devoted to single plant and sward trials with this grass. A "frequency of cutting" trial with annual grasses was carried out also.

The present year, 1932, has seen a further considerable extension of the work with perrenial ryegrass, cocksfoot, and white clover. The investigations into subterranean clover and Wimmera ryegrass are being maintained, and work with lucerne has been undertaken at the station for the first time.

Throughout this development the grass museum has been added to from year to year, and brief studies have been made on various other species, notably Phalaris, Red clover, the Lotus group, and Strawberry clover.

From time to time the members of the staff undertake extension work amongst the farming

community, lectures, field days, and demonstrations being held in various districts. They also act as judges in meadow hay and pasture competition, when advice is extended to individual farmers and lectures are given by request at public meetings.

Location and Area.

The pasture plant research field is located in the Burnley Gardens, situated some 3 miles from Princes Bridge, Melbourne, along Swan-street, a continuation of Batman-avenue. The gardens are bounded by the River Yarra on the east, Swan-street on the north, and the Richmond Park to the south and west. Its close proximity to Melbourne makes it easily accessible to visiting farmers.

The area devoted to investigational work is approximately 5 acres. The soil is a stiff grey clay loam, drained by both underground and surface drains. The average annual rainfall at the station is approximately 26 inches, fairly evenly distributed throughout the year.

STRAIN INVESTIGATIONAL WORK.

Subterranean Clover.

The first plant on which critical work was done was subterranean clover, a species which is adapted to a wide range of soil and climatic conditions, and is naturalized in all districts except the Wimmera and Mallee. Numerous collections of seed have been made in Victoria, and samples obtained from other Australian States, England, New Zealand, Germany, France and America. All have been sown in plots of 100 single plants and compared for differences. Botanical variations have been noted and used in describing and separating varieties—differences between leaves, stems, flowers and fruits.

From the pasture point of view, however, vegetative characters are more important. On this basis there have been separated early maturing and late maturing strains, leafy and stemmy strains, free seeders and shy seeders. Some wilt and die in late November, while others keep green into early January. The

Subterranean Clover Plots.

Ryegrass Strain Investigations—General view of single-plant plots.

different strains have been grouped, according to the time they commence to flower, into early, mid-season, and late flowering types. The early flowering types are sparse and stemmy, and die off early, whereas the late flowering strains last longer into the season and are dense and leafy. The mid-season strains, to which practically all commercial samples belong, vary between these two extremes. Production under pasture conditions may be expected to vary with the length of life and the degree of leafiness of the strains.

Some Observations Made at Burnley.

In a general way the various strains have come from districts to which one would expect them to be adapted—early strains from early districts of light rainfall, such as Mulwala, and late strains from late districts with liberal rainfall such as Bena. Numerous strains have been isolated of which those from the following districts are giving most promise:—

Early Types.—Mulwala, Springhurst, and Bacchus Marsh.

Mid-season Types.—Nangeela, Wangaratta, and the selection from Wangaratta—Burnerang.

Late Types.—Tallarook, Bena, Macarthur, Beaconsfield, Kyneton, and New Zealand selections.

A selection to which the name "Burnerang" has been given has been developed at Burnley from the seed of one original plant which was isolated from the Wangaratta strain. It has short runners and its leaves have an upright habit of growth and are relatively abundant in proportion to the amount of stem. This selection is a perfect example of the self-fertility of subterranean clover, in that the seed from one original plant has been multiplied, in two years, up to 20 lb. without any variants having appeared.

It is considered that when seed is available in commercial quantities the different strains will be capable of greatest development in the districts where they have been found, or in areas where rainfall and soil type are similar.

Wimmera Ryegrass.

With the object of improving the pasture lands of the lighter rainfall districts, observations on Wimmera ryegrass were begun at the Rutherglen State Farm some nine years ago, and a strain known as the Rutherglen new strain has emanated from there. In the autumn of 1928 the selections were transferred to Burnley. The difficulties of strain investigation in this plant are accentuated by the fact

that it is an annual requiring cross fertilization for propagation, so that the breeding of a pure strain must be regarded as impracticable. In 1930, however, the existing strains were classified into early, mid-season, and late strains, and since then the work has aimed at the development of "groups" of plants pure in this respect.

Observations.

It is considered that the field of usefulness of this plant may be extended if both earlier and later maturing strains than the ordinary commercial one are developed. Wimmera ryegrass makes splendid winter growth, is able to take advantage of short seasons, and may be satisfactorily maintained from year to year by re-seeding and light cultivation.

Perennial Ryegrass.

The possibility of clarifying the ryegrass position in Victoria prompted the establishment of these plots. Clearly much of the seed being sold as perennial is not true to name, in that it is not giving rise to perennial or long-lived plants. In order to discover the origin of such seed, extensive collections of samples of ryegrass seed were made from as many sources as possible. As it was desired to investigate the present sources of ryegrass seed, as well as possible future sources, samples were obtained direct from commercial growers in the Western District and from old pastures, at present not harvested for seed, throughout southern Victoria. In addition, samples of the shipments of seed entering Victoria were secured. Large quantities are imported annually into Victoria from New Zealand and the United Kingdom. Also eighteen samples of New Zealand seed were kindly supplied by the New Zealand Department of Agriculture. These consisted of three samples of each of the six types into which New Zealand ryegrass has been classified by Levy and Davies. A few samples were obtained also from Melbourne seed merchants.

Ryegrass Strain Investigation.

Broadcast plots subjected to frequent mowing; short-lived types die out—perennial types persist

Some 160 samples were collected in the first season, and special plots established for their investigation. Two types of plot were used for each sample, one containing single plants, and the other being a small broadcast plot maintained as a sward by mowing. The single plant plots have given evidence as to longevity and vegetative and botanical characters, and the broadcast plots evidence as to recovery and persistence under frequent cutting. The trial was devised, however, primarily as a test of the perenniality or length of life of the different lots, although eye estimations are made of their comparative growth.

Ryegrass Strain Investigations.
Close view of single-plant plots.

New Zealand certified permanent pasture seed has been used as a control in both types of plot, being systematically scattered throughout the single plant plots and sown alongside each broadcast plot. The latter plots were sown during the second week in May, 1931, and have been mown at intervals of from two to three weeks, according to the amount of growth made. Re-seeding was effectively stopped by this means. Seed for the single plant plots was sown in seed pans, and the seedlings transplanted out in the field during May and June, in rows 1 foot apart with 1 foot between the plants in the rows. Each line was represented by a plot containing six rows of eleven plants. These spaced plants were allowed to flower, and were then cut in the hay stage during late November. They were cut again five weeks later, and since autumn growth commenced have been clipped over twice. They will now be allowed to reach the hay stage before the next cut this spring (1932).

Observations.

These experiments have shown that all seed imported into Victoria, except New Zealand certified seed, is of a bad type; that from New Zealand being chiefly short-lived, and that from the United Kingdom being very unproductive and less persistent than the good perennial lots. The majority of the samples from Victorian old pastures have proved to be productive and long-lived types, and many samples collected from old pastures not previously harvested for seed indicate that it would be possible to harvest very much larger quantities of good seed than is at present collected.

Cocksfoot.

Investigations with cocksfoot were started in the autumn of 1929, when rows of Victorian, Akaroa, and Danish seed were sown. In the following year the work was extended a stage further by increasing the number of Victorian samples, using commercial samples of New Zealand, Akaroa, and Danish seed as controls. In 1931, single plant trials were undertaken, and are being maintained and increased. This year some 90 rows of single plants sown with seed collected from as many sources are established, and are undergoing critical examination. The seedlings are transplanted into single rows with the plants 2 feet apart in the rows. Each row is being investigated for the presence of persistent leafy plants and the proportion in which they are present.

Observations.

Although Akaroa cocksfoot is considered to be the best type obtainable commercially, these trials have indicated that for productiveness and longevity Victorian seed is equal to, and

Cocksfoot—single plants.

in many cases better, than the average New Zealand type under Burnley conditions. Danish cocksfoot has shown itself to be inferior to both Victorian and Akaroa lines. It is significant that large quantities of Danish seed and small amounts of Akaroa are imported into Victoria annually. The possibilities of a considerable expansion of the cocksfoot seed industry in Victoria are indeed very favorable, provided that it is developed in respect of superior strains and that clean viable seed is harvested.

White Clover.

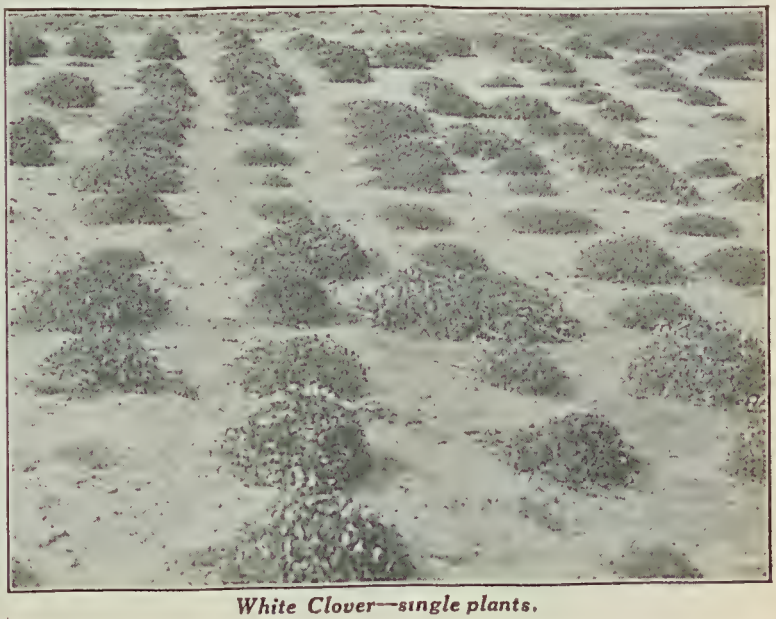
The work on white clover was begun in 1930, when a number of broadcast rows was sown. These included New Zealand and English strains, together with samples from many Victorian sources, including the irrigation districts. In 1931, further extensive collections were made and single plant trials were undertaken. Each line is being examined to determine its average characteristics in respect of leafiness, time of flowering, and length of life.

Observations.

These trials have demonstrated that there are distinct local Victorian strains in which early or late flowering, leafy or stemmy, and short or long-lived plants, may predominate. The seed of this plant is not, as yet, harvested in Victoria—our supplies coming from New Zealand and Europe—but it is evident that many of our volunteer stands of white clover, and more particularly those in the irrigation districts, are of an excellent type and well worthy of harvesting for seed. It is a definite loss to the State that the commercialization of our own strains has not been undertaken.

Future Work and Scope.

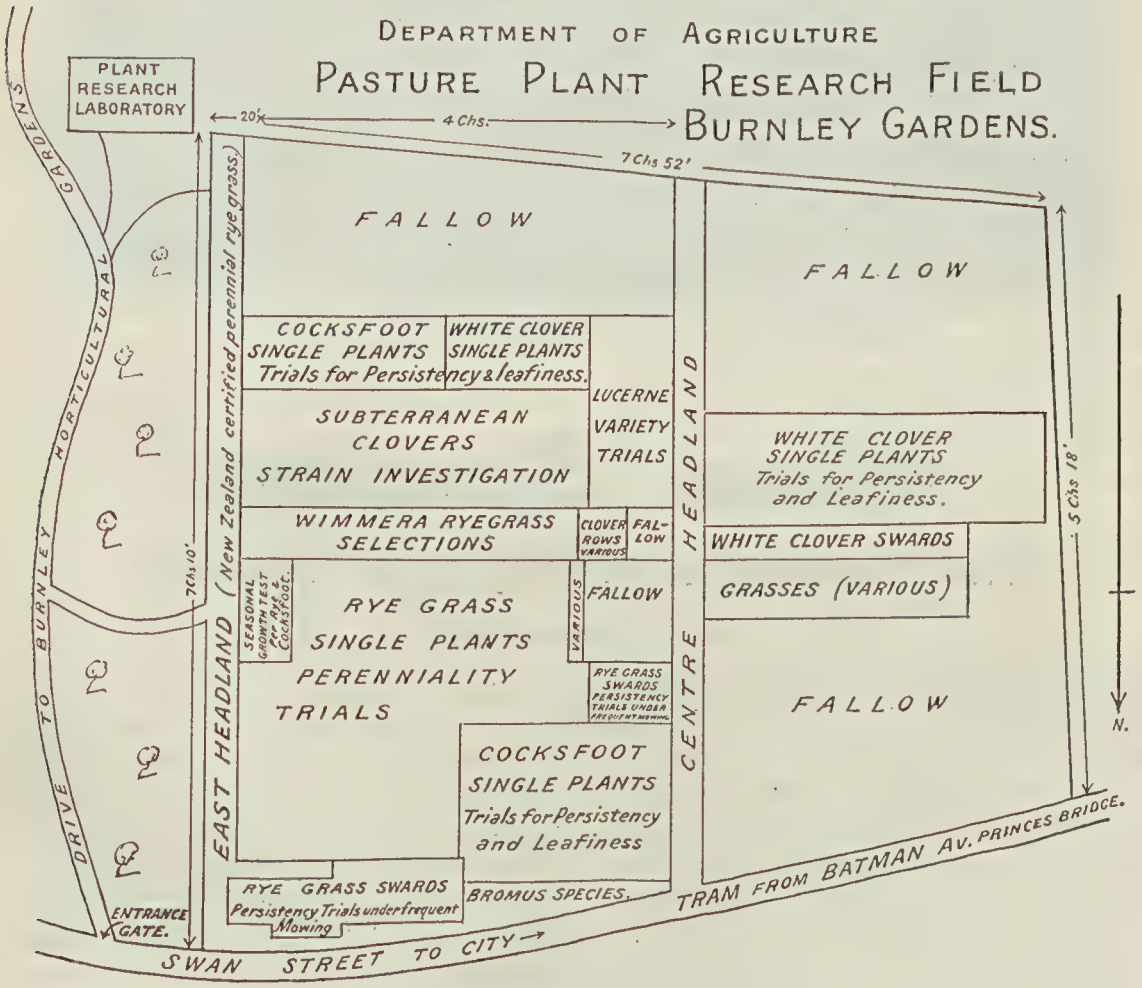
The prosecution of the investigations in progress will be directed towards the further examination of our principal grasses and clovers for the presence of clearly defined strains, and towards determining the suitability of these to the different climatic regions of the State. The differences between these regions



White Clover—single plants.

are considerable, and necessitate close and detailed study of pasture species in order that the types most suited to each may be determined, and the most productive pastures established on which to graze our increasing numbers of sheep and cattle.

The work so far undertaken, in addition to clarifying a very involved position in respect of ryegrass and cocksfoot in particular, has demonstrated the existence in Victoria of numerous strains of pasture grasses and clovers naturally selected by soil and climate, and by the special type of management which has been superimposed upon them. Information is steadily being obtained in respect of those elements which may most suitably be used in the establishment of both temporary and permanent pastures, and local farmers are being encouraged to harvest seed of these on a commercial basis and to undertake its orderly marketing. Some success has been achieved in this direction by the establishment of a Perennial Ryegrass Growers' Association at Colac, and a generally increased interest is being taken in the possibilities of pasture seed production in the State. The objective is to secure for Victoria entire independence in the production of seed for her own requirements.



Wheat Breeders at Work—State Research Farm, Werribee.

Wheat Breeding

The Production of Improved Varieties

By G. S. Gordon, Cerealist.

IMPROVEMENT in agricultural practice generally goes on so quietly and unobtrusively that the casual observer may be pardoned if he jumps to the conclusion that advance is very slow, or even that little or no real improvement is taking place. With regard to cereals, however, and particularly wheat, a study of the varieties in general cultivation during the past twenty years or so not only provides ample evidence of change and improvement, but also in the light of the greater knowledge of the underlying principles of plant breeding now available, warrants full confidence that even greater success may be achieved.

A suitable starting point for this survey is provided by the first report issued by the Wheat Improvement Committee in connexion with the Department of Agriculture. This committee was formed in 1908 with the approval of the then Minister for Agriculture, the late Hon. G. Swinburne, M.L.A., and consisted of the Director of Agriculture, Dr. Cherry; the Vegetable Pathologist, the late Mr. D. McAlpine; the Principal of Dookie Agricultural College, Mr. H. Pye; and the Superintendent of Agriculture, Mr. F. Lee. Mr. J. T. Pridham, now plant breeder in New South Wales, was appointed Wheat Experimentalist, in charge of the field operations at Longerenong.

The committee was charged with the initiation and conduct of a comprehensive scheme for the breeding of new wheats, to combine, as far as possible, the desirable characters of numerous varieties. Associated with the

scheme for the improvement of the yielding properties of wheat, provision was made for the systematic testing of the milling qualities of all varieties grown in the State. To enable this to be done, a miniature flour-milling plant, capable of turning out a commercial grade of flour, was provided and installed by the Department.

The formation of this committee was probably one of the most definite and important of the earlier efforts of the Department of Agriculture to place the work of wheat improvement on a sound basis. In a short time, however, departmental changes broke up the committee, and it ceased to function as a supervizing body.

During 1909 the committee issued a report in which sixteen varieties of wheat were considered worthy of being individually described and photographed. These varieties may, therefore, be regarded as the most promising and popular wheats then available. If we compare a list of these with a list of the sixteen most extensively grown wheats in Victoria last year, we find that only two, Federation and Yandilla King, remain. Three, Dart's Imperial, Purple Straw, and Marshall's No. 3, are recorded among the 77 varieties listed (but comprise an area of under 1 per cent. of the total acreage sown), while eleven are not even mentioned.

Of the sixteen popular wheats in 1909, Federation is the only one still grown extensively. This wheat, which was bred by the late William Farrer, of New South Wales, was introduced to Victoria shortly before the formation of the improvement committee, and rapidly won its way into favour till, in 1926, it occupied 44 per cent. of the total area sown to wheat in Victoria. Farrer's work in producing Federation was responsible for putting millions of pounds sterling into the pockets of growers. Federation not only marked a definite advance, but also set a much higher standard for plant breeders. During the past few years, however, it has lost its position as the most extensively grown variety, having been superseded by Free Gallipoli and Rance, both of which were bred at the State Research Farm, Werribee. These two wheats occupied over 55 per cent. of the Victorian wheat acreage last year against 7¼ per cent. of Federation.

Amongst the eleven wheats which are not now grown commercially are varieties which undoubtedly have high quality grain, such as Bobs and Comeback, and a disease-resisting type such as Florence; yet they failed in other respects. There are other varieties possessing these qualities, but with the exception of the flag smut resisting wheat, Nabawa, they are not in general cultivation. In short, they are such low yielders, or so unsuitable, that their production is unprofitable.

From this analysis it will be seen that, in the comparatively short period of 23 years, the most important varieties of wheat in Victoria have been almost completely superseded by improved types. It should be said also that, in the absence of any definite premium for wheat of superior quality, the general usefulness of a variety has been gauged by its prolificacy rather than quality. Thus it will be recognized that there are many characters to be combined in the "make-up" of a successful grain variety alone, without considering the different requirements of wheat for hay or other special purposes.

Such a wheat has to be suited to the rainfall and climatic conditions, soil, &c., of the district in which it is grown, and be able to resist diseases such as the various smuts, rusts, &c. It must also have certain characters to meet the requirements of (1) the farmer, (2) the miller, and (3) the baker. Of these, the farmer requires a variety which not only will yield well under average seasonal conditions but also can be readily harvested so that a good clean sample is turned out with the ordinary harvesting machinery. On the one hand, the grain must not be so tightly held by the glumes as to be "tough" when harvested, nor, on the other, so loosely held that it falls out or "sheds" in rough weather. The straw must be sufficiently strong to prevent "lodging," and should not break off at the ground level, or be too brittle in any part. The crop must "stand" well for a reasonably long period after ripening to permit of harvesting without loss should adverse weather or other circumstances delay the work. The farmer also desires the grain to be of good colour and to "weigh" well.

The miller wants a wheat which will mill readily, give a high percentage of flour, and leave a clean offal in the shape of bran and pollard. The baker requires a flour which will meet the popular demand for a white loaf with good texture, &c. The baking quality must be good, and it must be possible for him to make the maximum number of loaves per sack of flour.

There are other special requirements to be catered for. One of the most interesting and encouraging of these is the recent development

of an export trade, in addition to the local demand, for macaroni, vermicelli, and edible pastes. Such foods are made from what are known as Durum wheats, which, for various reasons, have not been extensively grown in Victoria. One of the chief characteristics of these wheats is the amount of gluten they contain. The recent expansion of this trade has warranted attention being paid to the production of a variety which will best suit the demands of manufacturers and growers under our conditions.

The plant breeder is met with demands for improvement from all these varying interests, and, at times, the value of different factors—important as they admittedly are—is somewhat unduly stressed. The farmer, the miller, and the baker all view the matter from their respective angles, while the task of the plant breeder is to place the value of all factors in true perspective, and get as close to the ideal as possible.

Space will not permit of a detailed description of the methods used in connexion with the operation of cross fertilization, or the various generations and stages during the period of "fixing," and testing the new varieties. Briefly, however, the aim of the plant-breeder is to eliminate the undesirable characters, and combine as many of the desirable ones as possible in the one new plant. When the produce of this plant has been tested and proved satisfactory, it is multiplied, and the seed distributed.

At the State Research Farm, Werribee, thousands of new crossbreds and selections are under observation and trial each year, but only a few have been considered worthy of being named and distributed. Of these, Ranee and Rajah were released to growers in 1921, and Free Gallipoli, Sepoy, and Ghurka in 1923. Last year the Werribee bred varieties were sown on an area of 2,116,000 acres, or over 65 per cent. of the total area under wheat in Victoria.

These new wheats have been estimated to yield at least 2 bushels per acre more than the varieties they displaced, which at, say, 3s. per bushel, is equivalent to an increased return of 6s. per acre for every acre sown, or approximately £650,000 additional annual wealth to the State.

Among the more recent crossbreds which have won their way through the preliminary tests at Werribee, and are now being tried out in the departmental "Observation" plots in various parts of the State, are a few which seem to be of special merit. One of these, a Rajah-Gallipoli crossbred, yielded 60 bushels per acre last year at Salisbury, in the Wimmera, and another, of Gluyas-Ranee parentage, has been giving superior yields to the improved selection of its parent, Ranee 4H, and the check plots of Free Gallipoli. Again, in the still smaller plots at Werribee, where selections for grain quality have been made, and where Nabawa has been used in the crossing programme for flag smut resistance, there is promise of improvement along these lines.

In conclusion, it may be said that there is justification for believing that from the material at present under observation, further useful varieties eventually will emerge.

Crossbred wheats under test in "Long Rows."

The Sheep Industry

Helpful Hints to Sheep-men

5.—The Sheep Blowfly.

By W. M. Lerew, G.M.V.C., Veterinary Officer.

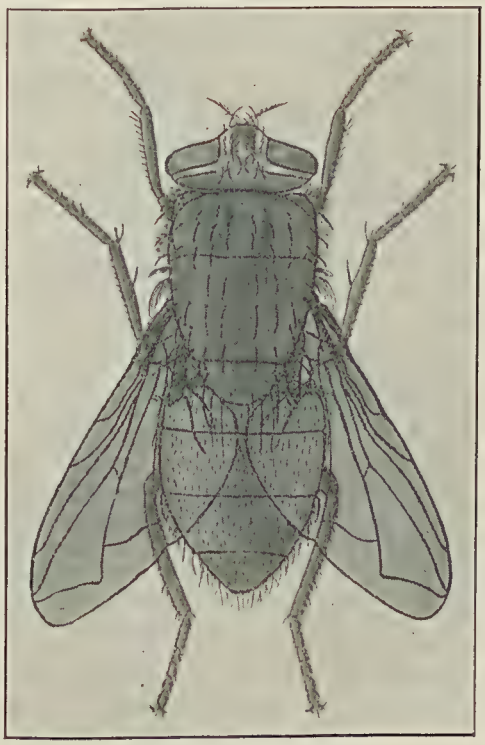
[Previous articles of this series, which appeared in the June, July, August and September issues of the Journal, dealt with the selection of ewes and rams, lamb marking, classing the wool clip and fat lamb raising.]

THE sheep blowfly is a pest that causes very serious losses to the sheep and wool industry throughout the world. Its control is a most serious question for Australia, for wool ranks as one of our greatest assets. The fly is increasing every year at a rapid rate and has become a considerable menace to the industry. Unless a very vigorous campaign is carried out against it a considerable drop in the value of the wool clip must occur.

As the number of sheep has increased the flies have multiplied, and at the same time they have changed in their habits. Formerly the blowflies were useful scavengers, and used to deposit their eggs on dead animal matter, but they now lay them on the wool of living sheep, and they have even been known to "blow" new woollen blankets.

It is a very difficult matter to evolve any treatment that will prove repellent to the fly and thus stop its attack, or that will rid the sheep of the maggots, without causing injury to the animal.

The natural breeding grounds for the flies are decaying carcasses of animals. Owing to deaths due to disease, accident and old age, and the losses of stock from starvation in drought periods, there is unfortunately no scarcity of these. The majority of these carcasses are not buried, but rot away on the surface of the soil, providing ideal conditions under which the flies can multiply.



Green Lucilia Blowfly.

Varieties and Life History.

Several different species of the flies have been identified, and their life history studied. Although all of them go through the same stages during their life cycle, a marked variation is shown in the time required for its completion. Not only is the life cycle of some varieties longer than that of others, but that of the same species will differ from time to time, depending on seasonal conditions.

Generally speaking, the life cycle is as follows:—The adult fly deposits its eggs, which

hatch out in from a few minutes to 21 hours. The larva or maggot after emerging from the egg is very active, and feeds on either carrion or living flesh. The pre-pupal stage may last from one and a half to ten days. When this stage is complete the larva loses its activity and seeks a suitable position in which to pupate. This position may be under a carcass, or the maggot may even burrow under the surface of the soil. The pupal stage is then entered upon, and this lasts for from five to fifteen days in summer up to three months in winter. The adult fly then emerges, and the life cycle is complete. There are several varieties of blowflies, but the following are the most common:—

1. Green Lucilia Blowfly (*Lucilia sericata*).
2. Larger Brown Blowfly (*Calliphora stygia*).
3. Smaller Brown Blowfly (*Calliphora augur*).
4. Smaller Green Blowfly (*Microcalliphora varipes*).
5. Metallic Blue Blowfly (*Chrysomyia rufifacies*).

The flies are found all over Australia, but the numbers of the different species vary considerably according to the season of the year, the altitude, rainfall, and temperature. Both the green varieties of blowfly predominate during the spring months, while the larger brown blowfly is most numerous in winter, and almost disappears in summer. The Green Lucilia blowfly is considered the worst variety here, and in a series of experiments carried out in South Africa it also proved to be the most prolific. The life of the adult varies from about a week to a month, and as they can travel nearly a mile per day a tremendous amount of country may be covered from the starting point where they hatched out. Owing to the number of eggs deposited by a female fly (up to 300) very active measures must be adopted to cope with the pest.

These flies attack a fresh carcass in the above order, and the green flies (*Lucilia*) will commence laying their eggs on the first day. The other species will feed on the carcass at the same time, but the brown blowflies will deposit their eggs on the second day. The maggots (larvae) of these flies are smooth, and their action tends to liquefy the carcass. When this takes place, about the third day, the Blue Metallic Fly (*Chrysomyia*) deposits its eggs, and from these active hairy maggots soon hatch out and start to devour the smooth maggots of the other species of fly. The Chrysomyia will not attack the carcass unless the larvae of the other varieties have already produced the state of liquefaction necessary The first three varieties may be classed as primary blowflies, and the last two as secondary blowflies. From the foregoing it would appear that the Chrysomyia might be looked on as a useful variety, and that every endeavour should be made to reduce the other varieties without killing off a proportionate number of the Chrysomyia. Up till recently the flies have been trapped indiscriminately, but the latest research work into the problem shows that if the traps are baited with keratin a very large proportion of primary flies are caught, and only a few secondary ones, and also the catch shows a predominance of females. The keratin is obtained by treating raw wool with ether and alcohol to remove all the grease and then washing in warm water. The wool fibre thus obtained is mostly keratin, and this is then treated with sodium sulphide. A small quantity of this is placed in the trap on a pad of cotton wool, which must be kept moist. Other baits, such as fresh liver and "blowfly soup," when treated with sodium sulphide are found to retain their effectiveness over a much longer period, and are also more attractive to the flies.

Method of Attack.

Fly strike will take effect only on a moist surface, because the young maggots quickly die if kept from moisture, consequently wounds from shears and lamb-marking or crow picks are most likely spots for the fly to attack. These are cases that can be readily seen, and proper antiseptic treatment quickly gets rid of the trouble. The most serious aspect of the case is when the fly strikes the wool without any wounds being present. This occurs most frequently in those regions which become stained by dung and urine. Rams are often struck near the base of the horns where the skin may have become abraded from fighting. Lambs may be struck about the head and neck, for these parts are liable to become soiled as the young suck their mothers. Ewes, when lambing often get the fleece soiled, and require careful observation. Damp wool attracts the flies; therefore close-woolled wrinkly sheep, whose fleeces will retain moisture for long periods are more liable to attack than are long-woolled

breeds, whose fleeces are not so dense, and therefore dry more rapidly. Diarrhoea or scouring from young grass or succulent food, or even heavily mineralized water, is another factor in soiling wool.

When a sheep is struck the maggots work their way through the wool till they reach the skin, which they attack, inducing intense irritation and causing the sheep to bite at the affected part. This will attract attention to the animal, which may separate itself from the flock, cease feeding, and show general uneasiness; when struck in the crutch it will probably stamp with either hind foot. The wool on the affected area appears stained, and if bitten by the sheep will be ragged. On examination a blackish discharge will be found soaking through the wool, and as this has a very foul odour it invites further attack from the flies. As the maggots grow they spread and damage the tissues further, so that the wool comes away, leaving a raw surface. If not treated the infestation will spread, the sheep gradually wastes away; gangrene sets in, and is followed by the death of the animal.

Control.

There are two ways by which the sheep blowfly problem may be attacked, namely—(1) prevention; and (2) treatment. Prevention must be the aim of the sheep breeder and scientist, as the discovery of an effective method will eliminate the need for treatment. Prevention must be sought either along lines which lead to the destruction of the flies or the maggots, thus preventing the completion of the life cycle, or by some means which will render the sheep immune from the attacks of the fly.

The most important and effective method is the destruction of their breeding grounds, which are dead carcasses and offal. This is most readily effected by means of burning, but this is often impracticable owing to scarcity of firewood especially on the plains, and also because of the risk of grass fires in the heat of summer. The latter risk may be lessened by the use of a portable incinerator, an additional advantage of which is that it requires less wood than burning carcasses in the open. If large numbers of carcasses have to be burnt in drought periods, the best method is to dig a narrow deep trench with sloping ends in the form of a cross, fill it with wood, and lay the carcasses on top, when they may be readily burnt. The trench should be dug in the open in as exposed a spot as possible, so that any wind that may be blowing will assist in the complete destruction of the carcasses.

If burning the carcass is out of the question, it should be opened up; this may lead to its being consumed by birds and animals; or if not eaten, then it will dry more quickly in the sun. If the carcasses are buried they should have at least 3 feet of well rammed earth over them, otherwise the flies, when they develop, will make their way to the surface. They have come up through 6 feet of loose soil.

Poisoning the flies and maggots by spraying the carcasses of dead animals with a poisonous solution has been used successfully and extensively both in South Africa and Australia, but great care has to be taken to prevent animals and birds gaining access to the poison bait.

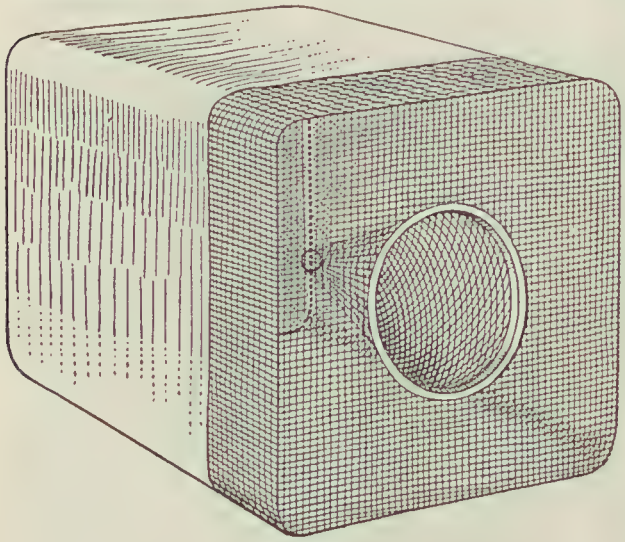
This method also entails a considerable amount of labour, as it is better to spray the baits lightly for several days, rather than to soak them in a large quantity of the poison in the first instance. Arsenate of soda is found to be the most suitable preparation to use, as it may be readily dissolved in water. To prepare the solution, place 2 oz. of arsenite of soda in a kerosene tin (4 gallons) full of water, and stir till completely dissolved. The best way to use it is to dig a narrow hole about 2 ft. 6 in. deep, open a dead sheep along the belly, and take out the internal organs; put these into the hole, and then put the carcass, belly upwards, on top of them, keeping the cut edges apart with a piece of stick, about 1 foot in length. Spray the carcass and viscera with the solution, and pour about a pint of it into the body cavity. This will keep the carcass moist for a longer period. Cover the hole completely with wire netting tightly pegged down; this will serve to keep animals out, and yet give free access to flies. The carcass should be sprayed with poison daily until it becomes hard and dry, when the hole should be filled in. Another useful method is to put some meat into a tin containing arsenic solution. This can be moved about from one place to another wherever the blowflies congregate.

Trapping the flies has been found a very successful means of helping to keep the pest in check, and is largely used both in Australia and South Africa. Many different types of fly-traps have been invented since the blowfly has become such a serious pest. Trap No. 1, illustrated herewith, has proved its worth, while Trap No. 2 has been used in South Africa with excellent results.

Trap No. 1.

With a petrol tin and some wire gauze, any handy man can make a trap, similar to that illustrated. Remove the end of the tin, cover the opening with wire gauze, which should overlap the sides about 2 inches. Let into the wire-gauze covering a funnel 4 inches across and 4 inches in depth, with an opening at the apex about the size of a threepenny piece. Paint the inside of the tin white; if the outside also be painted, the trap will last longer.

When the trap has been made, stand it upright and pour in about two quarts of water. Then drop in 1 lb. of meat, or half a freshly-skinned rabbit. Place the wire gauze over the rim of the tin, and firmly press down so that the funnel or cone will point downwards.



Trap No. 1.

In summer, fresh water should be poured through the top of the trap every week, and every second week about ½ lb. of meat should be added to the fermenting mass.

Before removing the gauze-top, the flies clinging to the under surface should be destroyed with a flare or a torch.

The efficacy of these traps is shown by the fact that, in a test in New South Wales, several were set out on 1st October, visited at regular intervals, and the bait renewed, but were not cleaned out until the new year. At a conservative estimate, each trap accounted for a "catch" of 100,000 flies for the three months. It may be reckoned that half of these were females. When it is remembered that each female blow-fly is capable of laying up to 300 eggs, there seems little room for argument as to the value of a trap as a means of control.

Trap No. 2.

Trap No. 2 consists of two petrol tins placed one above the other and held in position by a strip of sheet metal. The upper tin is the trap proper, and contains a wire-gauze cone or pyramid fastened in an upright position, its apex being 3 inches from the top of the tin and its base secured on the inside of the bottom edge of the tin.

The first step in making the trap is to mark out the windows in the sides and top of the upper tin. Details of these apertures can best be seen by reference to the accompanying sketches. They are made of such a size that there is a strip of tin 1 inch wide left all around them, except at their lower sides, where the strip is 2 inches wide. This leaves enough of the tin to give rigidity to the trap and enable the gauze to be fastened in place. Then mark out the hole "x" (Fig. 1) and the position of the cuts to be made in the bottom end of the tin, as shown in Figure 3. The round hole "*x*" (Fig. 1) is for the purpose of emptying the trap of flies when it is in operation. The hole is cut to fit the lid of a treacle tin, which is used to close it. Place the lid of a treacle tin with its inside surface against the side of the upper tin where it is to be fitted and scratch around its inside edge with a nail. The window on this side is made small so that plenty of room is left for making the hole. The upper edge of this window should be 5 inches from the top of the tin, and the upper edge of the hole "*x*" ½ inch from the top of the tin (Fig. 1).

Before cutting the apertures in the tin, small holes must be punched around the edges of the windows, using a thin nail and a hammer, and making the holes ½ an inch from the apertures, and 1 inch apart as at "*y*" (Fig. 1). These are for the purpose of sewing in the gauze windows, with thin copper wire. The apertures are then cut with an old pair of scissors or a tin cutter. In cutting out the bottom end of the tin, a strip 1 inch wide is left all around the inside of its bottom edge. Slit this strip at the corners of the tin as at "*a*" (Fig. 3) leaving four flaps "*b*" as shown in the figure.

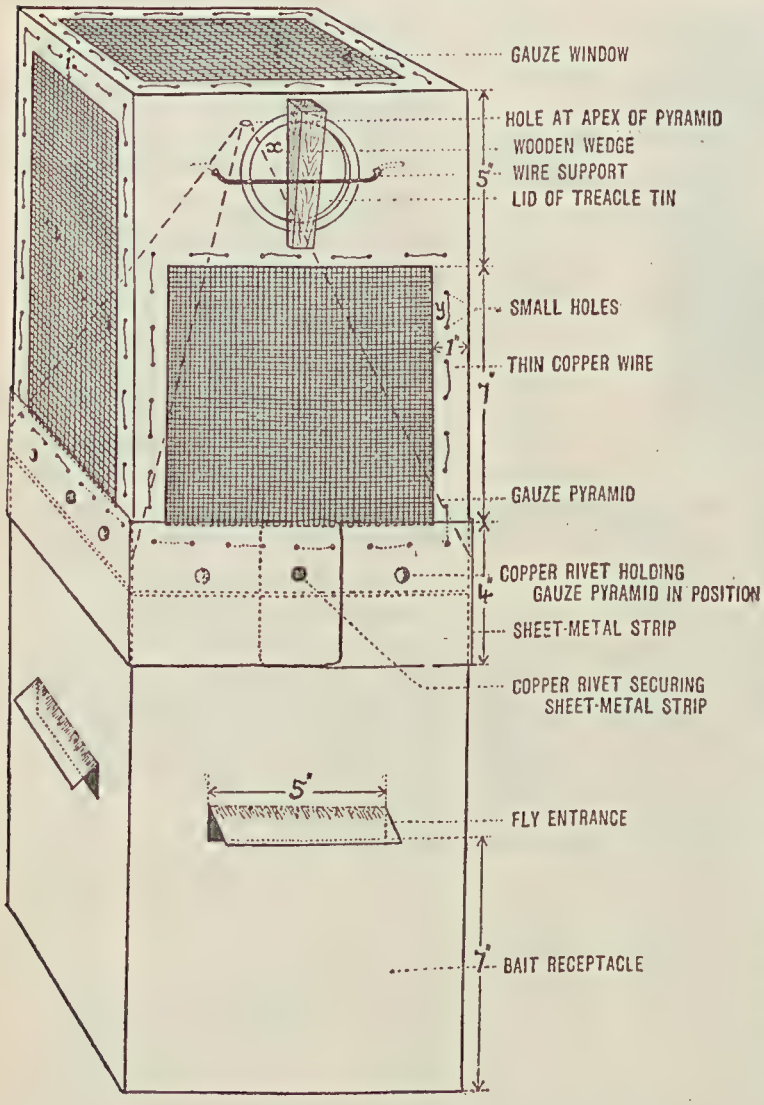


Figure 1.

Trap No. 2.

Two holes are punched with a stout nail, one at each side of the hole "*x*" (Fig. 1), and a stout piece of wire is bent through these over the hole, as shown in the figure. This piece of wire serves as a support for a wooden wedge which is used to keep the treacle-tin lid in place while the trap is in operation.

The gauze is next fastened into the windows. Pieces of good 12 or 14 mesh wire gauze, preferably galvanized, are cut to fit the openings so that there is an inch to spare on each side. They are fitted on the inside of the tin and sewn in place with thin No. 22 standard gauze, copper wire threaded through the holes "*y*" (Fig. 1). The square of gauze in the top of the trap should be sewn in first, then those in the sides, and finally the gauze cone is fastened in place.

The Construction of the Cone.

It is a common but mistaken idea that the cone of one of these traps is difficult to make. There is no difficulty if a little care is taken. It is best, however, to cut out a paper pattern of the cone, and when this is found to fit correctly, cut the gauze to coincide with it. The pyramid or cone has four sides to correspond to the sides of the trap, each side being a triangle with its base as long as the width of the trap, and its height nearly that of the height of the cone. The pattern is as shown in Figure 4, on which the measurements are given. First strike out the arc of a circle with centre A and radius of 12 inches. Then mark off the points B, C, D, E, and F along this arc so that they are $9\frac{1}{4}$ inches apart. Draw lines joining these points and to the point A, and proceed as shown in the figure. Strips of gauze 1 inch wide are left along the line AF and at BC, CD, DE, and EF (Fig. 4), in order to sew the cone into shape and to fasten it into the trap. The gauze when cut to shape is folded along the lines AC, AD, AE, and AF, so that the strip AF overlaps the edge AB, and these are then sewn together with copper wire, the same as was used for sewing in the windows. The apex of the cone will then be closed. After the cone is riveted into the trap, a hole must be made in the top of it through which the flies are to enter. This is best done by pushing a thick pencil up through the tip of the pyramid; the gauze will part at this point, the thin wires bending aside, and leaving a round hole of the required size.

To fasten the cone into the trap, its base is fitted under the flaps "*b*" (Fig. 3), which were left on the inside edges of the bottom of the

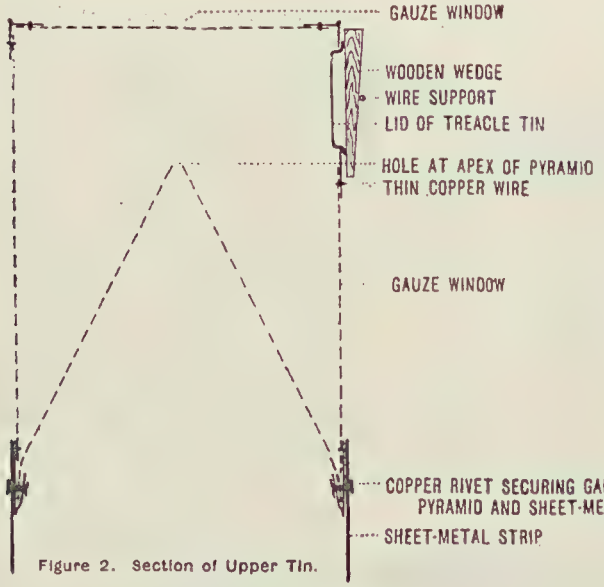


Figure 2. Section of Upper Tin.

Trap No. 2.

tin, and which are now bent inwards against its sides, and secured tightly over the strips of the cone. BC, CD, DE, and EF (Fig. 4). The flaps are secured with split copper rivets such as those used in harness making. These rivets are put through the sides of the tin, the strips at the base of the cone and the flaps. Two rivets through each flap are sufficient (see section of upper tin, Fig. 2).

In order to keep the upper tin in position on the lower tin, a strip of sheet metal or paraffin tin, 4 inches wide and 40 inches long, is riveted on the outside of the bottom edge of the upper tin. It is fastened so that it projects 2 inches below the edge, and over the upper edge of the lower tin. Split copper rivets are used to fasten it in place. It serves to strengthen the trap in addition to keeping the tins in position. The ends of this strip will overlap on one side of the trap, and one rivet should be put through both ends at this point. The upper tin or trap proper is now complete.

The lower tin or bait receptacle consists simply of a petrol tin of the same size as that used for the upper tin. Its top is cut open, and four slots are cut in its sides through which the flies, attracted by the bait, enter. These slots, one on each side of trap, are formed by making a horizontal cut, 5 inches long, at a distance of 7 inches from the bottom of the tin on each side. At each end of these cuts are perpendicular cuts, 1 inch long, running up from them. The flaps so produced are bent outward, as shown in Figure 1. The object of these flaps is to prevent light from entering the slots, and so prevent the flies from being attracted out through them after entering. The flaps do not hinder the flies from entering, because the flies find their way to them by walking up the outside of the trap.

When completed, the trap, and particularly the inside of the lower tin, should be painted with good thick paint to prevent it from rusting. The gauze should not be painted, as this hinders light from shining through it.

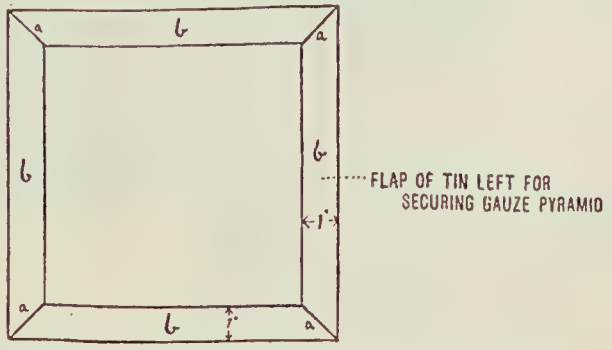


Figure 3. Bottom of Upper Tin.

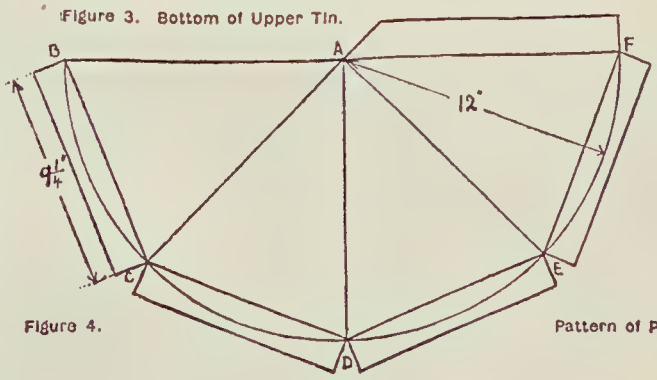


Figure 4. Pattern of Pyramid.

Trap No. 2.

It has often been suggested that a larger tin be used for the trap proper fitting over a smaller tin as the bait receptacle. This has been tried, but it has been found better to use tins of the same size for both the upper and lower part of the trap, and to rely on the strip of sheet metal to keep them together.

Numerous forms of bait have been recommended; the best bait to use depends largely on the kind of fly to be caught and on the materials that are available. Sheep blow-flies are very strongly attracted by decaying animal matter, in which they breed naturally. The faster it decays, and the greater its stench, the more attractive it becomes. Solid meat like that cut from a dead cow or a horse remains attractive longer than entrails and odd scraps. Entrails, &c., are very good, however, and are easily obtainable on most farms. Rabbits are often used, and are a good bait.

South African Maggot Trap.

A new method of disposal of carcasses has been tried, and has given very good results. It consists in the use of a maggot trap. The trap is built in the form of a trough with open ends, and is made of two 6-feet sheets of corrugated iron bolted together side by side with ordinary verandah bolts, and suspended with pieces of fencing wire between four fence posts so that the open ends are directly over two petrol tins. These tins have their tops cut open, so that there is a rim of tin left about ½ inch wide. If this rim is bent down slightly, it will prevent the maggots from crawling out. The upper edges of the trough also are bent inwards for the same reason. A little soil banked round the tins will keep them from being blown over.

The carcasses are thrown into the troughs, and not poisoned. Flies are attracted to them, and lay their eggs, and soon the carcasses are swarming with maggots, which leave only the skeletons and dried up skin. These can easily be burnt or buried.

The maggots when full grown crawl away from the carcasses and fall into the petrol tins underneath the open ends of the trap, where they can be killed by pouring a little water and kerosene over them.

Preventive and Curative Treatment.

The most effective preventive methods are crutching, dipping, and either jetting or swabbing.

The Sheep Maggot Trap in use.

The most successful way to prevent fly strike is to keep the wool short on those parts that are most liable to become soiled by dung and urine, and so that exposure to the air will dry the wool quickly. Shearing does this each season, and remains efficient for about six weeks, by which time the length of wool prevents quick drying. A modified form of shearing, namely, crutching, has become the usual method of prevention. This consists of shearing the wool from about 2 inches above the tail to the point of the hocks down either side of the fork or crutch. To be successful, this must be carried out over a sufficiently wide area as shown in the accompanying photographs. The best time to crutch the sheep is just before lambing, so that the ewes will not become so soiled when the lamb is born.

Dipping is very useful for two reasons. It gives immunity from fly attack for about three or four weeks, and kills any maggots on a sheep that has already been blown. The dip used generally is one containing arsenic. It is not advisable to dip sheep that have suffered extensive injuries to the skin, because of the risk of arsenical poisoning through absorption.

Jetting and Swabbing.

Jetting is the application of a solution to the crutching area of a sheep by means of a high-pressure pump with a nozzle of about 3-32 inch in diameter. A series of tests carried out recently by the Council for Scientific and Industrial Research showed the following dressings to be of considerable value:—

Monsol, 5 per cent. solution in water.

Lime sulphate, 5 per cent. solution in water.

Both these preparations should be used with a small hand pump to make sure that they penetrate the wool. The best oily dressing proved to be a 4 per cent. solution of carbolic acid in whale oil, with 5 per cent. of carbon tetrachloride added.

When the sheep are being jetted, the nozzle of the hose should not be held nearer to the sheep than 12 inches, and the pressure should not exceed 160 lb. to the square inch, otherwise there is considerable risk of cutting the skin, especially if the wool be short. The sheep should be treated in a race, and about a quart of the solution should be applied at a constant pressure, decreasing to 100 lb. if the wool is very short. It is always advisable to spray a few inches beyond the crutching area.

Swabbing is a means of applying a preventive or curative application to that portion of the crutch that does not readily lend itself to jetting. A small mop made of rags on the end of a stick is used, and the application may be poured on the sheep and spread with the mop, or the mop may be dipped into a tin containing the preparation, and then thoroughly rubbed over the affected area. The preparations used for swabbing are usually oily or soapy emulsions.

Treatment of Fly-Blown Sheep.

During the fly season, frequent inspections of the flock should be made, so that cases may be detected before serious harm is done. When any sheep are noticed to be struck they should be treated at once. Many kinds of dressings have been applied with varying success. In our experience, a solution of lysol (one tablespoonful to a quart of water) has been found effective as a preliminary dressing. When applying a dressing, always surround the "struck" area by treating the outside margin first so as to prevent the maggots from escaping into the clean area, and then treat the whole area so that all maggots may be destroyed. The wool over the "struck" area should then be removed with the shears, care being taken to have a margin extending into the clean wool. After treatment, affected sheep may be drafted off and placed in a small paddock where they can be kept under close observation. As a rule, one dressing will be found effective, but if the animal be badly "struck," it should be yarded each day and dressed until recovery is complete.

When maggots have penetrated the flesh through wounds, it is more difficult to get rid of them unless the wound be an open one. In that case the dressing can be poured into the wound, where it will come into direct contact with the maggots. With a punctured wound, the best plan is to force some of the dressing through a syringe to the bottom of the wound, and thus prevent the maggots from burrowing deeper with pus which may be formed. This treatment also answers for wounds that underrun the skin, but if these appear extensive, the skin should be slit so that the full extent of the damage may be seen, and the maggots reached easily. Any scabs that have maggots under them should be removed, and the wound will quickly heal again when freed from the maggots.

To be successful, a dressing must be sufficiently strong to kill all the maggots, but must not be injurious to the sheep or wool. It should be mild and healing, so that the wounds will recover quickly. It must also be obnoxious to the flies so that they will not restrike the part, and therefore it must be retained on the wool and skin so that a temporary immunity may be obtained.

The most successful dressings are made up as follow:—

Creosote, 6 parts.
Turpentine, 20 parts.
Olive oil or raw linseed oil, 40 parts.

Or,

Cotton seed oil, 45 parts.
Benzine, 40 parts.
Oil of tar, 10 parts.
Carbolic acid, 5 parts.

(All by volume.)

(*a*) Incorrect way. (*b*) Correct Way.

Crutching Sheep.

These dressings may be applied with a swab after dislodging the maggots and cleaning up the affected area with the solution of lysol 1 tablespoonful to a quart of water, as mentioned above.

Precautions Recommended.

By careful selection of the breeding sheep a great deal can be done to minimize the risk of fly strike. In an endeavour to discover the conditions which predispose sheep to blowfly attack, series of observations were carried out in New South Wales over a period of four years by Dr. Seddon and Messrs. Belschner and Mulhearn. Briefly, the results of their investigations are as follow:—

(1) individual sheep vary in susceptibility;

(2) the sheep most frequently struck in one season will also be most frequently struck in succeeding seasons;

(3) on comparing sheep frequently struck with those not struck, the only marked difference was that those more frequently struck were more wrinkled in the breech than the other group;

(4) if the flock be divided into groups according to frequency of attack, the degree of wrinkling is found to vary in accordance with frequency of fly strike;

(5) ewes free from breech wrinkles, mated with similar type rams, will breed lambs less susceptible to fly strike.

In addition to the above, our own observations show us that when drafting the ewes the breeder should cull out all those showing excessive wrinkles, especially on the hind quarters, also those with a very narrow breech. By breeding only from the selected ewes with rams showing the same characteristics, it is possible to build up a flock that will not be nearly so susceptible to blowfly attacks. Moreover, treatment will be greatly facilitated owing to the wider and flatter surface to be crutched.

All wrinkly ewes and those of bad conformation should be kept in convenient paddocks, so that they can be inspected frequently, and if a small temporary catching yard is constructed in each paddock the sheep can be handled and examined without excessive droving. By having the flock divided up into separate paddocks they may be inspected more thoroughly, and there is less likelihood of a badly-struck sheep being missed.

The merino sheep is more often affected by fly strike than the other breeds, and it has been found that the fold of skin on either side of the breech is most often selected as the point of attack. These skin folds or wrinkles are due chiefly to the introduction of the Vermont strain into our local sheep. It is now recognized that the ideal sheep to resist attacks by the fly is one with a plain wide breech free from wrinkles. This will take a long time to attain by selective breeding. A practical and simple method has been evolved to remove the folds of skin quickly and safely. The sheep or lamb is set up as for tailing, and the fold of skin is firmly pinched between the jaws of a Burdizzo castrating instrument. The fold of skin inside the jaws of the instrument is then cut off with a sharp knife. There is no bleeding, and no tendency for the cut edges to separate. The fold on the opposite side is then treated in the same way. No further treatment should be necessary.

The rams should be carefully counted when inspecting, as one that has had his horns invaded by maggots will leave the flock, and will not mate with the ewes. Dehorning of flock rams, when lambs, might profitably be carried out in districts where the flies are numerous.

When the flies are troublesome, do not keep the sheep yarded longer than necessary, as the flies are generally found in the greatest numbers round sheep yards.

6.—"Scabby Mouth" in Sheep and Lambs.

(Infectious Labial Dermatitis).

By R. J. de C. Talbot, B.V.Sc., Veterinary Officer.

As the name suggests "scabby mouth" in sheep and lambs is characterized by the formation of purulent ulcers, which later develop into scaley crusts or scabs. The most common seat of the lesion is in the region of the lips and nose, but in some cases they are present around the coronets also, and on the udders of ewes which have affected lambs at foot.

Lambs and sheep under the age of twelve months are most commonly attacked, but animals of all ages are susceptible, and in severe outbreaks practically the whole flock may suffer. Goats also may be affected.

In mild cases the disease readily responds to suitable treatment, but if neglected some mortality probably will ensue. Death may be due to starvation resulting from the animal's mouth being so ulcerated that it cannot eat, or it may be that the lesions on the leg cause a lameness so acute that walking is difficult.

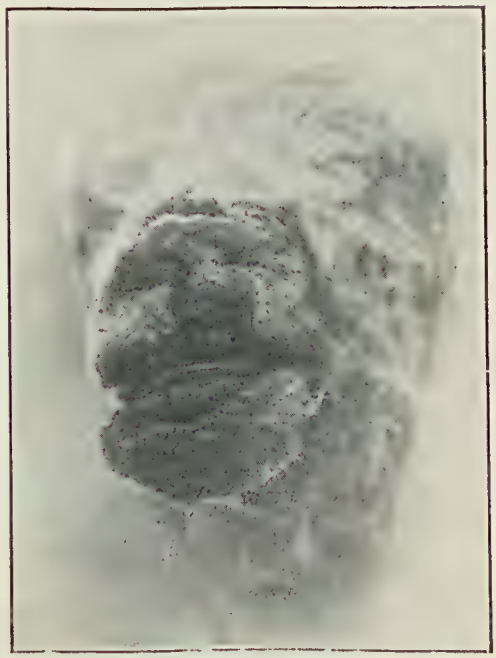
Outbreaks occur from time to time in various parts of the State, but only occasionally does the disease assume the character of a severe epidemic in any district, as sometimes happens in the United States of America and Europe.

Cause.

As a result of recent work carried out in various parts of the world (in Australia by H. R. Seddon, D.V.Sc., and H. G. Belschner, B.V.Sc., of New South Wales), it has been established that the disease is due to a virus (living organisms so small that they cannot be seen by the most powerful microscope), similar in many respects to those causing cow-pox and small-pox. The lesions may subsequently be invaded by other organisms such as the bacillus of necrosis, which was formerly thought to be the cause of the disease.

For the virus to gain entrance into the tissues some slight injury to the skin is necessary, but this need be only the most minute abrasion such as would be caused by the animals feeding in fairly dry pasture, or being hand fed.

The most severe outbreaks of the disease which have come under notice have occurred during the winter or late spring of a year in which there was an abundance of old dry feed.



"Scabby Mouth", showing lesions on nose and lips of lamb.

Symptoms.

The ulcerations are found most commonly on the nostrils and lips, less frequently on the coronets. In simple cases the first lesions noted are a number of small pustules about the size of a pea; these become larger until they break and the pus exudes This dries, and forms a crust or scab, which has a warty, dry appearance, and if it be lifted the tissues underneath will be found to be very much inflamed and ulcerated.

The complaint appears very quickly, and unless precautions are taken to isolate the affected members of the flock, it will spread rapidly until a large number contract the disease—in some outbreaks up to 90 per cent. of the lambs are affected.

In severe cases the ulcers are present on the membrane inside the mouth, and sheep so affected rapidly fall away in condition. The ulcers on the coronet are similar to those on the lips and nose, but are usually more severe.

Lesions on coronet of lamb.

both fore and hind legs may be affected, the front and sides just above the hoof being the commonest seat of the trouble. In chronic and neglected cases the inflammatory processes may spread to the tissues inside the hoof, and cause acute lameness.

When a lamb still sucking has the ulcers on its lips, it may carry the infection to the ewe's udder, and a similar ulcerated condition develops on that organ.

The period of incubation for the disease is about two days, and it runs a definite course of about three weeks.

Treatment.

If early treatment is adopted, a complete cure is certain. It is important to remember that the disease is infectious, and all affected animals should be isolated. If they have recently been through a shearing shed or yards these should be disinfected by being sprayed with a 5 per cent. solution of some suitable disinfectant.

For mild cases the affected parts should be washed with a 1 per cent. solution of lysol (one tablespoonful to 2½ pints of water), or 1 per cent. Monsol, and the scab removed; then apply the following ointment:—

Monsol or cresol, 5 parts.
Sulphur, 10 parts.
Lard or vaseline, 100 parts.

This treatment should be repeated three or four times a week, and in mild cases a cure will soon be effected. In severe cases, after the scabs have been removed by bathing them with an antiseptic solution, and the ulcers appear to be deep, and are discharging a foul-smelling pus, the inflamed surfaces should be painted with tincture of iodine, and afterwards dusted with a powder made of one part of chloride of lime to two parts of boric acid. This treatment should be repeated as often as possible. Animals which have been affected should not be allowed to rejoin the flock until at least a fortnight after recovery.

If possible, a paddock in which an outbreak has occurred should not be restocked until it has been cultivated or burnt.

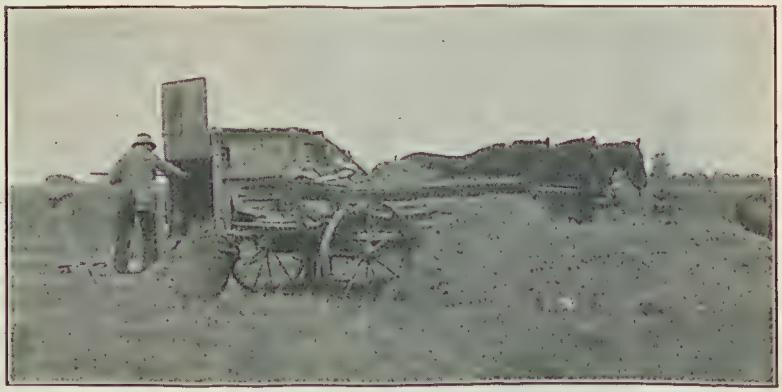
"Scabby Mouth," showing lip lesions in ewe.

Harvesting Pasture Seeds

Ryegrass; Cocksfoot; White Clover; Subterranean Clover

By E. D. Cameron, B.Agr.Sc., Assistant Agrostologist.

DURING the last two or three years questions relating to agricultural seeds have been receiving increasing consideration. Farmers have come to realize that seed is perishable, and cannot withstand extreme conditions without losing some of its inherent vitality; that soil and weather conditions at the time of and immediately after, sowing must be favorable if maximum germination, giving rise to healthy and productive plants of a perennial nature, is to be obtained, and that certain types or strains of plants are more suitable to particular soil and climatic conditions.



Harvesting Ryegrass with the box stripper.

It is almost impossible, however, without elaborate laboratory tests and field trials under an expert eye, to distinguish between the seeds of good and bad strains or of plants of an annual or perennial nature. For this reason farmers in many districts have decided to harvest seed from their own fields, the character of which they know, rather than risk buying seeds of an inferior type. Unfortunately, at the present time it is not possible to purchase with any degree of reliability seed of known strains, the exception being certain New Zealand certified seeds. Apart from the advisability of sowing down other fields with seed of known origin there is the very definite commercial outlook. Seed harvested from old and productive stands of perennial ryegrass, cocksfoot, and white clover, provided it is clean and well formed, and is of a truly perennial nature, will always command a market which is profitable to the grower. At present the harvesting and sale of such seeds is a sideline availed of in flush seasons, but it may well develop into a profitable major operation.

The object of this article is to outline a few of the fundamental practices to be adopted in the successful harvesting of the seed of our four major pasture plants—Perennial Ryegrass (*Lolium perenne*); Cocksfoot (*Dactylis glomerata*); White Clover (*Trifolium repens*); and Subterranean Clover (*Trifolium subterraneum*).

Perennial Ryegrass.

If a field of perennial ryegrass is to be harvested it will be necessary to close the area to stock some six to ten weeks before harvesting, in order that the plants may recover from grazing and produce a bountiful crop of seed heads. If closed after the hot weather has set in the plants may have reached the dormant stage, and will not then run to seed, while if closed too early loss of grazing will result. The best time to close the field will depend very largely on seasonal conditions.

In the harvesting of this grass one of the main difficulties encountered is that complete removal of all seeds in the head is not possible at the time of harvest, because the head matures unevenly, the top seeds being ripe while those at the base are still immature. When the seeds at the base of the head are ripe those at the

A old pasture of Perennial Ryegrass running up to a seed crop.

[*N.Z. Journal of Agriculture.*]

top will have fallen, or would easily be shed on shaking by wind or rain. Just before this stage has been reached is the best time to harvest, as then the ripe top seeds are all saved, and many of the lower ones are sufficiently forward to mature into plump germinable seeds if the curing process is carried out properly. Of course, the time of harvest will vary according to seasonal conditions, but, as a general rule, a field will be ready in late December or early January, immediately after two or three hot "ripening" days.

The methods adopted vary to some extent according to the machinery on hand, but the principles throughout remain the same if a satisfactory and saleable sample is to be obtained. When the seed is at the stage ready for cutting it may be removed with an ordinary box stripper, a stripper-harvester, or a reaper and binder. In the case of the box stripper the coarse material collected must be passed over a wire-netting table to remove the long straws and coarse rubbish which, if left, will considerably increase the bulk for future handling. The coarse material has a tendency also to promote uneven drying, with the risk of a "fusty" sample being obtained. With the stripper-harvester the material is winnowed in the machine, and is immediately ready for drying. Thorough and even drying of the seed is essential if one is to obtain a clean, hard and bright seed which is readily saleable, easy to handle, and likely to give satisfactory germination when sown. In order to secure this the seed is spread out on hessian, or a tarpaulin, to a depth of 3 to 4 inches, and left in the field for a period of from two to three days to dry. During this time it should be forked at least twice a day to prevent sweating.

An alternative curing method is that widely adopted in New Zealand. After passing through the riddle table or being taken from the box of the stripper-harvester, the seed is placed in chaff bags, which are filled to one-third or less, tied at the mouth, and slung saddle-wise over a wooden fence. The bags may be shaken occasionally with advantage. The circulation of the air around the bags under this method has a considerably greater influence on curing than when the seed is left

Curing Perennial Ryegrass Seed.

lying on a tarpaulin on the ground, which may be damp and communicate its moisture to the seed. Since the dissipation of heat and the drying of the seed both depend on the free circulation of air, the advantages of this method will be readily apparent. When perfectly dry the seed is collected and removed to a damp-proof store, there to await a convenient time for winnowing. The winnower used may be simple or elaborate, but in either case the removal of light seeds, chaff and weed seeds is all-important. The cleaned seed passing from the winnower is bagged immediately, and is then ready for sale. A "5-bushel" bag when full weighs from 80 lb. to 105 lb., according to the bushel-weight of the seed, which depends on the length of time the field has been closed to stock, the weather at the time of ripening, and the freedom from weeds and foreign matter. Yields of from 10 to 15 bushels per acre are usually obtained.

The reaper and binder is sometimes used on farms where the harvesting of seed is not a regular practice, but where a heavy crop occasionally appears in a good season, and this machine is the only one available. The field is cut just before the seed is fully ripe, when it will remain in the head and withstand the shaking involved without "shedding." After cutting it is stooked, and when dry put through a threshing machine and subsequently winnowed. Whatever the method of harvesting found most convenient the drying or curing process must be undertaken immediately, and carried out carefully and thoroughly. This is the critical operation in obtaining an attractive sample of perennial ryegrass seed that will give satisfaction to the purchaser.

A fuller account of the harvesting of perennial ryegrass appeared in the August, 1931, issue of this Journal. This is obtainable in pamphlet form from the Agrostology Branch, Department of Agriculture, Burnley Gardens, Burnley, E.1.

Cocksfoot.

The difficulties encountered in the harvesting of cocksfoot are not so great as is the case with perennial ryegrass. The seed head ripens fairly evenly throughout and is cut when nearly mature, so that as much of the seed as possible is collected in a ripe condition. The tendency of the ripe seed to shake out very easily also necessitates cocksfoot being harvested when not too mature.

Usually the fields are closed to stock several weeks before harvesting, which in normal seasons takes place during January, and after two or three hot ripening days. It is usual to harvest seed from orchards, gardens, roadsides, and other sheltered places where the plants are more or less undisturbed during spring and run to ear in abundance.

In hilly country, the usual habitat of cocksfoot, the difficulty of cutting with any machine at all makes it necessary to cut by hand with sickles. The heads are cut off at a convenient height and transported to a common spot where they are threshed either by a small power-driven thresher or with a hand flail. The material is then subjected to a very careful winnowing, which will remove much rubbish, consisting of light seeds, empty shells, chaff, weed seeds, and other foreign matter. When clean and uniform in sample the seed is bagged and ready for sale. This method is adopted very largely in New Zealand, and is recommended for Victoria, particularly for the farmer who is sowing down small areas annually on his own farm. An alternative method, and that employed on cultivable ground, is the use of the reaper and binder. When the grass is well grown, and not too ripe, the machine is put through the field and the crop taken off. As soon as they are dry the sheaves are carted to a threshing machine for treatment, and the seed obtained is subsequently winnowed to a clean sample.

Yields of cocksfoot vary according to climatic conditions, the productivity of the plant itself for seed production, and the methods of harvesting used, but will be somewhere in the region of from 200 to 400 lb. of cleaned seed per acre. With this plant also a profitable sideline may be instituted, which will have the added advantage that a farmer will know the character of the seed he is sowing.

White Clover.

The harvesting of white clover has not yet been undertaken on a commercial scale in Victoria, probably because of the fact that, although it is a widespread pasture plant, it seldom forms a crop by itself, and consequently the cost of harvesting and cleaning would not be justified. Lack of knowledge of the methods to be adopted and the high cost of machinery have been other factors. The irrigation areas, however, now contain many pure stands of white clover, which offer excellent opportunities for the harvesting of seed.

White clover undoubtedly was introduced into Victoria by the early settlers, and is now sown down regularly in the development of our pasture areas. It has spread over a large tract of country south of the Divide, where soil and climatic conditions are suited to it. Its recognition as a perennial and summer-growing plant suited to hard grazing under favorable climatic conditions has led to its inclusion in pasture mixtures in districts favoured with a rainfall of not less than 27 to 30 inches.

An old stand of White Clover suitable for harvesting for seed.

In New Zealand white clover has been harvested for some years, the seed usually being taken from a volunteer crop of at least four years' duration. Normally the ley is anything up to or even exceeding ten years old. The usual practice is to close the field to stock in October, and harvest the seed crop in late December. It is not unusual for a second crop to be taken in February or early March, provided weather and other conditions are suitable. The crop is generally cut with a reaper to which a metal follower is attached, and from which a man rakes off the produce, which is immediately horse-raked into windrows to dry. Should rain fall the windrows are turned several times, until sufficiently dry to allow of carting. The material is then threshed, winnowed of all impurities, and bagged. If a second crop is to be taken, the land is top-dressed with superphosphate and harrowed immediately after the first harvest. This practice, which aims at a quicker recovery by the plant, is advised even if a second crop is not to be harvested.

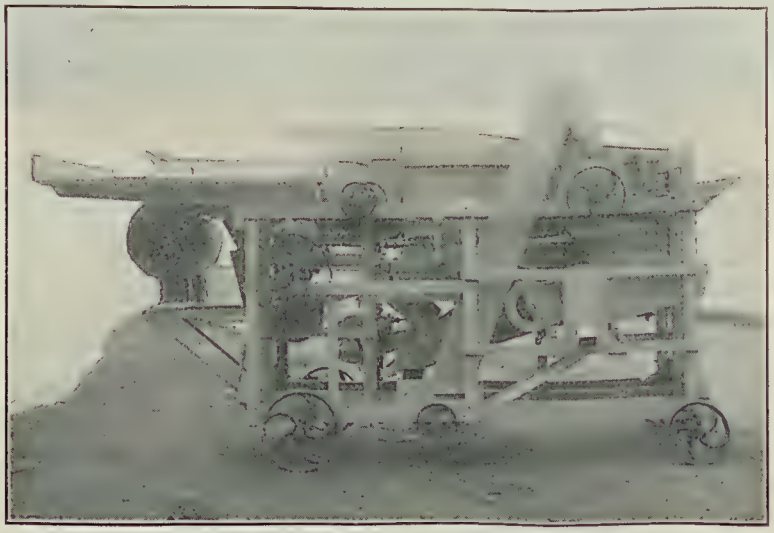
An alternative method is the use of a special type of stripper fitted with chain beaters which "gather" the close-growing heads. This machine is not infrequently used on the oldest swards where the heads are low, and an admixture with other plants exists. The chain beaters tend to have a selective action in that they gather the low heads most effectively, and miss the taller growing species. The seed from the stripper in then dried, threshed, winnowed, and bagged ready for transport to other parts of the farm or for sale. The yield of seed of white clover which can be expected varies according to the age of the stand. A long-lived stand usually contains smaller but more persistent plants, so that a smaller yield of some 150 to 200 lb. results. Harvesting from younger and more vigorous stands tends to select the shorter-lived and quicker-growing strains, which very closely resemble ordinary white Dutch clover. From these areas 400 to 600 lb. of seed per acre usually is taken. Seed from old stands gives rise to plants very similar to the English wild white clover, which is a denser, smaller-leaved, and more persistent plant. In New Zealand seed from "stubble" crops, that is, crops arising in the stubble of wheat, oats, or barley, is usually bigger, brighter, and with a higher germinating capacity than that from old swards, and is therefore more readily saleable. However, the value of seed from purely perennial

stands is becoming appreciated more and more, and this is slowly taking the place of "stubble" seed.

Subterranean Clover.

The peculiar habit subterranean clover has of burying its seed head in the soil makes the harvesting of the seed laborious rather than difficult. If a field is to be harvested it is usually grazed only lightly in the spring, so that it can grow to full maturity and produce an abundance of seed. If the latter is to be used for farm sowings only, it is horse-raked when ripe, that is, when the vegetative parts are dead. It is then threshed to separate the stems from the burrs. If no thresher is available the bulk is passed through a chaffcutter and then the burrs winnowed from the stalks. Although the seeds are not removed from the burr they are considered to be quite satisfactory for the farmer's own use. The practice is to sow from three to four times as much burr as would be required with cleaned seed. The burr is quite readily delivered from the manure box of the drill if mixed with super.

For seed to be marketed it is usual to hand-rake the area. This gives about twice as much seed as is obtained from the same area with a horse rake. The coarse material is then either threshed or put through a chaffcutter and winnowed to obtain the free burr. This burr must then be treated in a dehulling machine made specially for the removal of the seed from the outer coverings of this particular clover. Unfortunately dehulling machines are expensive, and are beyond the reach of the individual farmer. There is the possibility, however, that a group of farmers could finance the purchase of such a machine, which could be used by all. Experimental work has shown clearly that there are various strains of subterranean clover suited to different sets of climatic and soil conditions, but as yet the purchase of these particular strains is not possible. It is hoped that within the next year or two individual enterprise will make such strains procurable. The use of late maturing strains, it is hoped, will help to lengthen the grazing period offered by subterranean clover and, on the other hand, the use of early strains, which are quick-maturing, and can grow satisfactorily on a rainfall as low as 18 inches, will extend the field of usefulness of this remarkable plant into areas of light and erratic rainfall.



A Subterranean Clover Threshing Machine.

Packing of Citrus Fruit

A Review of the Position

By

Basil Krone, Fruit Packing Instructor.

Nailing Down.

DURING the last few years a rapid and very marked improvement has taken place in the grading, packing, and system of selling citrus fruit. Prior to this period most of the fruit was packed, but in some instances it was simply filled into one of the several types of cases then in use, the "long" bushel case being chief amongst them.

The systems of packing were many and varied —some very good, others very bad. So far as the marketing or the retailing business was concerned, the containers were supposed to hold a bushel of fruit, and this was the most or the least that was known of the contents, as the quality was not indicated in any way, nor was the fruit so constantly uniform as it is at present.

To-day we have one case only (the Australian "dump" bushel) for oranges and lemons. This has been standardized for the trade in Victoria. Not only have the size and shape of the container been standardized, but, in addition, the fruit is graded according to quality and size. The number of oranges or lemons contained in the case is shown, consequently a person can buy any one of the recognized lines of oranges on our market with perfect confidence, knowing that they are consistently good.

The citrus grower undoubtedly is justly proud of these achievements, but as conditions are continually changing, the Victorian Department of Agriculture desires to acquaint every grower in the State with some of the salient points about these changing conditions which are important and vital to the producer.

What the Buyer Wants.

After seeking quality, the buyer desires a well filled case of oranges containing one of the recognized counts. Let us suppose that one of these counts is "126" (a standard count). The novice who puts 127, 128, or other foreign count of oranges in the case thinking he is giving good measure, will find himself penalized through his "account sales." Experience has proved to the buyer that it is impossible to place even one extra orange of a given size for a certain count in the case. All counts other than those standardized are known as foreign counts, and, if used, are a clear indication of lack of uniformity in the sizing. A table of the diameters and counts sought for in the market is shown at the end of this article. It might be well to point out that the diameters shown are intended only for fruit that has been reasonably well "sweated."

What the Grower Wants.

The producer, of course, desires to please his customer, and in fighting for sales by giving well-filled cases, has gradually increased the diameters of the fruit for the respective counts. There has been a tendency to overdo this. Instances occur of cases with such an enormous bulge, and fruit in them of so great a diameter, that both are almost at bursting point.

The retail trade finds that such fruit develops mould quickly, and is in a state of deterioration long before it should be. The grower certainly knows that cases must show a slight bulge, not only at the packing shed, but also on arrival at the market, and if this is not so, his "account sales" will suffer by at least 1s. per case.

Recommendations.

The grower has the option of selling his fruit packed level with the top of the case, and receiving 1s. or more less for it, or packing it with a bulge to secure market price. Needless to say, most growers adopt the latter method, but not all with success, because of the above-mentioned tendency to overdo the bulge.

To ensure a good firm pack that will keep reasonably well after the retailer has purchased it, the fruit should be properly sweated. It has been noted that the keeping qualities of citrus fruit are greatly enhanced by careful handling and proper sweating. Undoubtedly some varieties need different treatment to others, for instance, Valencia oranges and grapefruit have wonderful keeping qualities, and although these do not require so much sweating as do lemons or navel oranges, it is preferable to sweat them to a certain extent in order to maintain a firm pack, which, owing to natural, rapid shrinkage, cannot otherwise be obtained. (Grapefruit after being a week or ten days off the tree, frequently appear as if they have only just been harvested.)

On the other hand, navel oranges and lemons are extremely sensitive to the treatment they receive. It is imperative that each fruit be clipped, not pulled, from the tree. Let the grower who claims that neat and careful pulling is just as good, examine the plucked stalks under a magnifying lens. He will see minute splinters on each stalk caused by the pulling; these rub against other fruit, rupturing the cells, and causing breakdown.

Navel oranges need periods of from a week to ten days to sweat properly. Lemons require the same time, but for some purposes this latter fruit needs longer. Valencias need from three days to a week. Mandarins do not require sweating, but should be harvested a day or two before packing. The commercial life of this fruit depends very largely upon how it is handled and packed. The mandarin cannot tolerate pressure in packing to the same extent as other citrus fruit; the peel crushes too easily, even when ordinary care is taken. This crushing is almost imperceptible to the packer. When packers' fingers become soiled from the oil exuding from the rind, which frequently occurs, they should realize that the packing is too tight.

Mandarins, lemons, oranges, and grapefruit should be harvested with great care; the picker wearing a glove on the hand that handles the fruit, which should, for reasons previously mentioned, be cut, and not pulled, from the tree. The fruits should be placed in fairly shallow containers in order to restrict the weight, which is inevitable if too many fruits rest one upon another. With mandarins, in particular, it is absolutely essential if "dump" cases are used, that these, after packing, be stacked on their flat side. The "long" bushel case is normally stacked on its "flat." The accompanying illustration (Fig. 1) shows a case of mandarins packed in the "dump" case with both lid and side removed. From this the packer will readily realize that this position of the fruit is satisfactory for its safe carriage if the case is correctly stacked on its side.

Fig. 1.—Mandarins packed in the "Dump" case.

Figure 2 illustrates a case of oranges which have been sweated, and held in the case nearly four weeks before the photograph was taken. In this particular instance, there was not 1 per cent. of waste. Compare this with ordinary

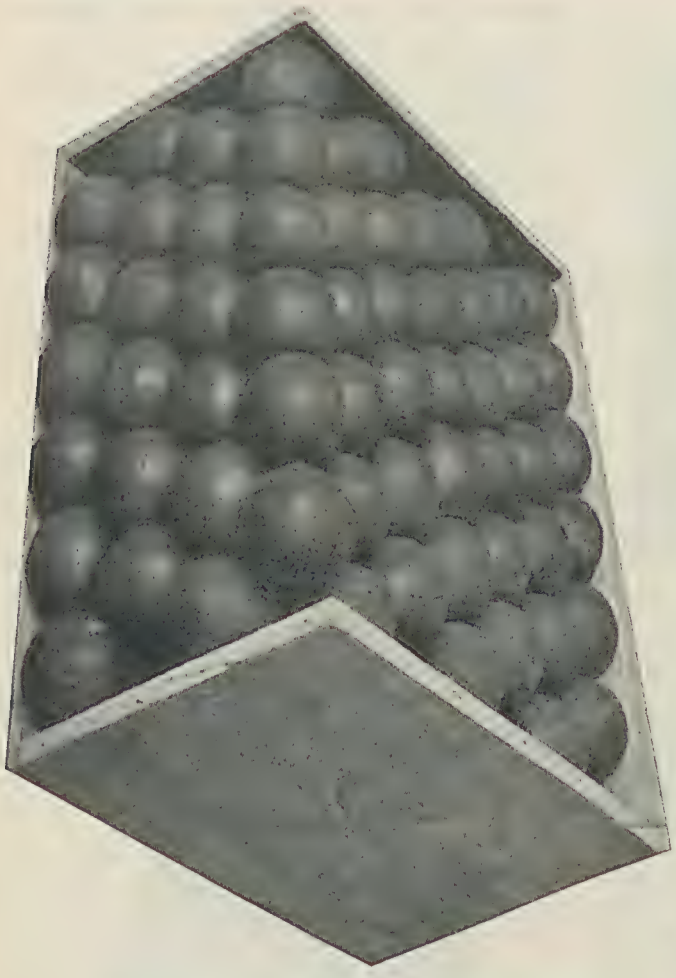


Fig. 2.—Australian "Dump" case of 2½ inch oranges with lid and side removed.

marketing conditions to-day, in which, if navel oranges are purchased in the market, and held three weeks, an average of 25 per cent. waste occurs, due chiefly to insufficient sweating and packing too tightly while the fruit is fresh.

Figure 3 illustrates a case of grapefruit packed for local market. Heavy loss due to waste is not occurring with this fruit, but shrinkage is great, and slack packs are prevalent. The Department of Agriculture has published a chart dealing with the packing of this fruit in the "dump" case, which should largely assist in overcoming these troubles. This chart, together with others for lemons and oranges, is appended.

Figure 4 illustrates a "dump" case of lemons. To ensure a good firm pack that will remain with the retailer free from deterioration for a reasonable period, lemons should be harvested when not more than 2½ inches in diameter, irrespective of colour, and well sweated.

A case of oranges packed for export is shown in Fig. 5. Criticisms regarding cases of Australian fruit on the London market being under weight are received frequently. It has been stated in the press that some cases of Californian oranges have been as much as 10 lb. gross per case heavier than the Australian. Experiments here definitely prove that if the right class of orange be selected, properly sweated and packed, they will compare favorably with the weights of the best American lines that can be produced.

To maintain satisfactory weight in our cases, it is imperative that oranges of certain diameters be selected. The diameters shown in the packing chart are the largest that it is possible to adopt for their respective counts without injury to the fruit. It should be pointed out, however, that these diameters are entirely unsuitable for fresh fruit, which, although it may fit and look well in the packing shed, will invariably open up with a large percentage of waste, and be considerably under weight. This may be better

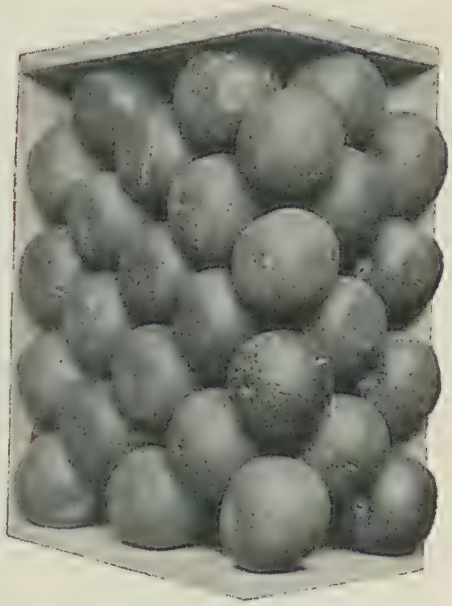


Fig. 3.—A case of grapefruit packed for the local market.

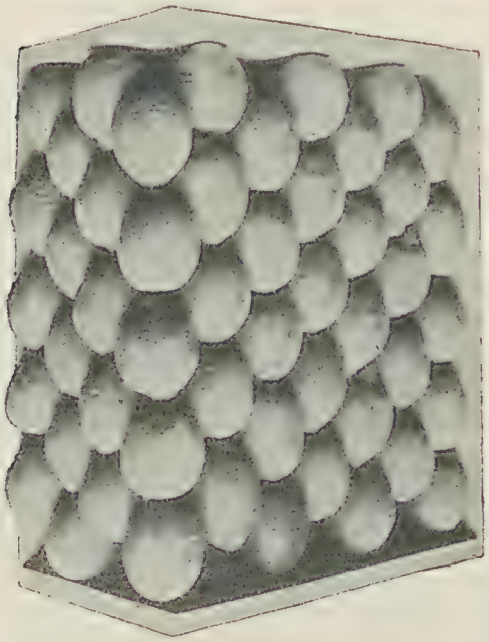


Fig. 4.—Lemons packed in "Dump" case for local market.

understood if it is explained that, in various packing experiments, the diameters of the fruit reduced themselves by more than $\frac{1}{8}$ inch each during the sweating period. Oranges that were $3\frac{1}{8}$ inches in diameter when harvested, packed the 150 count in the export case; these, after sweating, packed the 176 count in the same case. Similar results were obtained in the "dump" case, the 140 count became the 154 count, and 154 count became 168. From this it is readily seen how important it is to sweat the fruit carefully in order to prevent underweight cases.

Citrus fruits vary a great deal in weight. Lemons are a heavy variety, while grapefruit are comparatively light. In addition to this, the weight varies even with the same variety; for instance, oranges of good texture and quality weigh considerably heavier than those of a coarse, dry character, and those harvested very early in the season lighter than those harvested later.

Victorian citrus growers, however, through bud selection, and a process of elimination, are gradually reducing the quantity of inferior type which has been a "bugbear" to their trade.

The following list showing weights of cases of citrus fruit serves to show what might be expected in a reasonably well packed case of fruit. The weights, of course, are approximate, but are the average of various packing house lines. In all instances the fruit has been weighed, exclusive of the case.

In Victoria, every district packing house, without exception, has expensive and up-to-date

NETT WEIGHT OF CITRUS FRUIT IN THE "DUMP" CASE.

Count.	Washington Navels.	Thompson Navels.	Count.	Lisbon Lemons.	Count.	Marsh's Grapefruit.	Count.	Early Imperial Mandarins.
	lb.	lb.		lb.		lb.		lb.
248	55	51¼	330	51½	112	46	441	53½
200	54½	48½	297	51½	96	45	432	53
182	54½	48	270	51	84	44	405	56
168	54½	48¼	248	49	75	43½	378	57½
154	54	48	225	50	68	43	360	56
140	53½	49	203	51	60	40¾	351	58
126	53¼	48½	180	51	53	40¼		
112	53	49	160	50	45	37¼		
96	53	48						
84	51	48						
75	50¾	47						

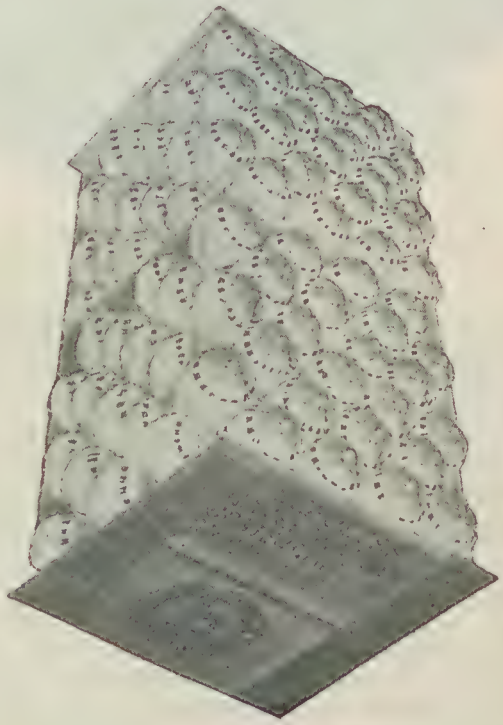


Fig. 5.—Case of oranges wrapped and packed for export.

Average Weight of Individual Oranges and Grapefruit.

Size.	Washington Navels.	Australian Navels.	Marsh's Grapefruit.
in.	oz.	oz.	oz.
2¼″	3⅛	3	..
2⅜″	4	3½	..
2½″	4⅛	4	3¾
2⅝″	5⅛	5	4⅛
2¾″	5¾	5½	5½
2⅞″	6¼	6	6
3″	7⅛	7	6½
3⅛″	8	8	6¾
3¼″	9½	9	7¼
3⅜″	10	9¾	8¼
3½″	11	11	8¾
3⅝″	12¾	12	9¼
3¾″	13	13	10½
3⅞″	15	14¾	10

equipment for handling fruit, therefore it might be opportune at this juncture to stress the use and abuse of packing house machinery. What manager would waste time putting oranges through a sizing machine if they grew as even as billiard balls? He realizes the less handling the better it is for the fruit. If this is logical, why put perfectly clean, fine textured oranges through soaking tanks, washer brushes, &c., as one frequently sees. Such equipment should be installed only to clean the dirty fruit that some growers unfortunately produce. It is much more economical to produce clean fruit by effective spraying and fumigation than by putting it through a scrubbing machine in a packing shed. There are progressive growers in this State who, year after year, grow clean fruit which should never go through a scrubbing machine. Of course, it is not possible to grow 100 per cent. clean fruit; had it been so, washing machines would never have been invented. Fortunately, present-day equipment is very efficient, and the days are past when

[Continued on page 540.

Standard Counts for Lemons in the "Dump" Case (18 x 8⅔ inches x 14¼ inches).

Approx. Size.	Pack.	Layer.	Layers.	Total.	Remarks.
1¾″	3-3	6 x 5	10	330	Small
	3-3	5 x 5	9	270	Large
	3-2	6 x 6	9	270	
2″	3-2	6 x 5	9	248	Small to medium
	3-2	5 x 5	9	225	Medium to large
2¼″	3-2	5 x 4	9	203	Small
	3-2	4 x 4	9	180	Medium
	3-2	5 x 4	8	180	
	3-2	4 x 4	8	160	Large
2½″	2-2	6 x 5	7	154	Small
	2-2	5 x 5	7	140	Medium
	2-2	5 x 4	7	126	Large
2¾″	2-2	4 x 4	7	112	Small to medium
	2-2	4 x 3	7	98	Medium to large
3″	2-2	3 x 3	7	84	Small to large
	2-2	4 x 3	6	84	

Standard Counts for "Emperor" Mandarins in the "Dump" Case (18 x 8⅔ x 14¼ inches).

Stylar ends face each side of the case.

Approx. Size.	Pack.	Layer.	Layers.	Total.	Remarks.
2″	3-3	7 x 6	9	351	Small
	3-3	6 x 6	9	324	Large
2¼″	3-2	8 x 7	8	300	Small
	3-2	7 x 7	8	280	Medium
	3-2	7 x 6	8	260	Large
2½″	3-2	6 x 6	8	240	Small
	3-2	6 x 5	8	220	Medium
	3-2	5 x 5	8	200	Large
2¾″	3-2	5 x 5	7	175	Small
	2-2	6 x 6	7	168	Large
	2-2	7 x 7	6	168	
3″	2-2	7 x 6	6	154	Small
	2-2	6 x 6	6	144	Large

Standard Counts of Oranges for Export in Californian Export Case.

Inside measurements, clear of the division, 24 inches x 11½ inches x 11½ inches.

Size.	Pack.	Layer.	Layers.	Total.	Remarks.
2½″	3-3	4 x 4	6	288	
2⅝″	3-3	4 x 3	6	252	
2¾″	3-3	3 x 3	6	216	
2⅞″	3-2	4 x 4	5	200	
3	3-2	4 x 3	5	176	
3⅛″	3-2	3 x 3	5	150	
3¼″	3-2	3 x 2	5	126	
3⅜″	2-2	4 x 3	4	112	
3½″	2-2	3 x 3	4	96	
3⅝″	2-2	3 x 2	4	80	

Tobacco Growing

Lessons from the 1931-32 Season

By W. J. B. McDonald, B.Agr.Sc., Assistant Inspector of Agriculture, and G. E. Coghlan, Tobacco Expert.

THERE is every indication that the area to be planted to tobacco in Victoria for the coming season will approximate fairly closely to that planted out last year. It is possible that there may be a reduction of acreage in the Goulburn Valley, but it is anticipated that increased plantings in many newer districts will compensate for that decline.

During a recent visit to the North-East, it was noticed that quite large areas intended for planting with tobacco were only then being broken up from lea land. Evidence such as this tends to indicate that last year's belated rush to get in the maximum area possible is likely to be repeated this season. This method of procedure is an unfortunate one, as the resultant crop usually is below standard. A brief review of last year's results may serve to emphasize this point.

Anticipating ready sales, irrespective of the quality of the product, very many growers last year sacrificed their normally efficient methods of planting out, followed by early irrigation and cultivation, in a scramble to complete the sowing of an acreage entirely outside the capacity of their plants. This delay of irrigation in irrigable areas and of the necessary cultivation in non-irrigable areas, seriously affected the quantity and quality of the subsequent tobacco crop.

In many instances in the Goulburn Valley and North-East, the application of water was delayed until crops were suffering from premature maturity. When rain did occur, the tobacco crop apparently revived and grew vigorously, but frequently this was a secondary growth rather than the rejuvenation of the original growth. Continuity of growth is essential to the production of the best class of leaf, but many growers last year did not take reasonable steps to ensure that condition being fulfilled.

Cut-worms and insect pests were particularly bad in many districts. Immediately the young plant is set out, steps should be taken to afford it some protection from the attack of grubs, but growers were so busy completing their planting that no time was available in which to attend to the plants already out. As a result, the laying of poison baits was delayed in many cases until the plant was very badly damaged—in some instances so badly as to necessitate a considerable amount of re-planting. In a great number of instances, however, transplanting was completed so late that the replacement of misses in the field was not possible.

These factors had an important influence on the general yield per acre, which, in many districts, was surprisingly light. In any particular district the cost of production per acre does not decrease in direct proportion to the yield, but rather maintains a comparatively constant level. It will be fairly obvious, then, that the lower the acre-yield the higher will be the cost of producing each pound of the cured leaf. In a great number of fields visited last season, ordinary attention to detail would have enabled the same total yield to have been obtained from a 20 per cent. smaller area. This estimate is made on a very conservative basis.

When the harvesting and curing period arrived, further difficulties intruded themselves. Generally speaking, barn space was inadequate, necessitating overcrowding of the leaf during curing. This caused sweating, and, in many cases, excessive sponging. In the field it was found difficult to pick an even sample of leaf, largely because of the fact that growers had failed to exercise their usual discrimination in the selection of plants. As a result, many fields contained a motley collection of varieties which ripened unevenly and could not be cured together. Quite apart from this mixing of varieties, many seedlings which should never

have left the seed-bed were set out in the field. As a result, the barns contained a large proportion of both over-ripe and immature leaf, the latter subsequently proving to be absolutely unsaleable.

Those growers who maintained a sane outlook throughout the season, and refused to depart from their established standards of efficiency, should have no difficulty in disposing of practically the whole of their crop at remunerative prices. Taking the State as a whole, however, it must be admitted that there is far too great a proportion of the crop which, owing to various avoidable causes, is unfit for market. Growers must realize that, quite apart from overseas competition, there is a distinct possibility of serious interstate competition for the Australian tobacco market. Ultimately this in itself is bound to result in a lowering of prices paid for local leaf, and if tobacco-growing is to maintain its present rate of return to growers, this high proportion of wastage must be eliminated. This can be effected only by strict attention to detail in all the phases connected with the growing, harvesting, curing, and marketing of the crop. The first step in this direction is the limiting of the acreage planted to that which can be handled conveniently.

An irregular strike, giving a big percentage of waste area.

A fair proportion of last year's crop is still in the hands of the growers—in some cases all of the crop—not necessarily because of any unsuitability for market, but because the buyers have not visited the property since the leaf has been graded and baled. The necessity for care in the storage of this leaf has been

[*Continued on page 543.*

Early Irrigation Pays.

Potato Manurial Trials

A Review of the Results

By J. T. Ramsay, Potato Expert.

A GENERAL review of the experimental work carried out by the Department of Agriculture in connexion with the manuring of potatoes under Victorian soil and climatic conditions appeared in the February, 1932, issue of this Journal. The results tabulated in that review covered the whole of the tests up to the end of the 1930-31 season. They showed clearly that, so far as their response to manurial treatments was concerned, certain districts could be grouped together.

Further figures for the season 1931-32 are now available, and these have been computed in conjunction with those of previous years, to show the effects, over the full period, of the various manures in different districts. These latest figures show very slight alterations in the averages obtained up to 1931, and must therefore be accepted as being substantial corroboration of the correctness of the findings previously recorded.

An outstanding feature of these trials has been the phenomenal success, both in Gippsland and the Western and Central districts, of the combination of superphosphate and ammonium sulphate. To further emphasize the beneficial influence which this combination of fertilizers exerts on the potato crop, tables I., II., and III., have been prepared. Table I. shows the average yields obtained from the various manurial treatments at four Gippsland centres, viz., Childers, Catani, Korumburra, and Fish Creek, all of which give a somewhat similar response to fertilizers.

The wide difference between the unmanured plots and those manured with superphosphate and ammonia is very striking. In the case of these four Gippsland districts the tests have been conducted annually since 1923, and remarkably consistent returns have been obtained year after year. If £5 per ton be taken as the average price of potatoes during the period of the tests, then the increased return obtained from the use of the superphosphate and ammonia amounts on the average to no less

Potato Plots at Beech Forest.

than £19 per acre, obtained for an average expenditure of approximately £2 10s. per acre. These figures constitute a convincing proof of the advisability of applying the "6 and 1" mixture to potato crops in the above districts.

TABLE I.—POTATO MANURIAL TRIALS.

Average Results at Four Gippsland Centres, Childers, Catani Korumburra, and Fish Creek, from 1923-24 to 1931-32.

Manure per Acre.	Average Yield.	Number of Tests.	Average Increase.
	T. C.		
Super., 3 cwt.	5 12	24	69
Super., 6 cwt.	6 4	24	87
Super., 9 cwt.	6 9	22	90
Super., 6 cwt., pot. sulp., 1 cwt.	6 7	22	86
No manure	3 6	24	..
Super., 6 cwt., amm. sulp., 1 cwt.	7 2	24	116
Super., 6 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	6 18	24	109
Market garden, 6 cwt. ..	4 14	6	59
Basic Phos., 6 cwt. ..	4 4	6	42

NOTE.—The apparent error in percentage increases in the case of the 9 cwt. super. plot, and the 6 x 1 dressing, is explained by the fact that these figures were obtained by comparison of the results from the same years and number of years in which they were tested together.

The fact that 6 cwt. per acre appears to be the optimum rate of application for superphosphate, and the failure of potassium sulphate,

will also be noted from Table I. Attention has already been directed to these points in the text dealing with the results from individual centres (see September and October issues of this *Journal*).

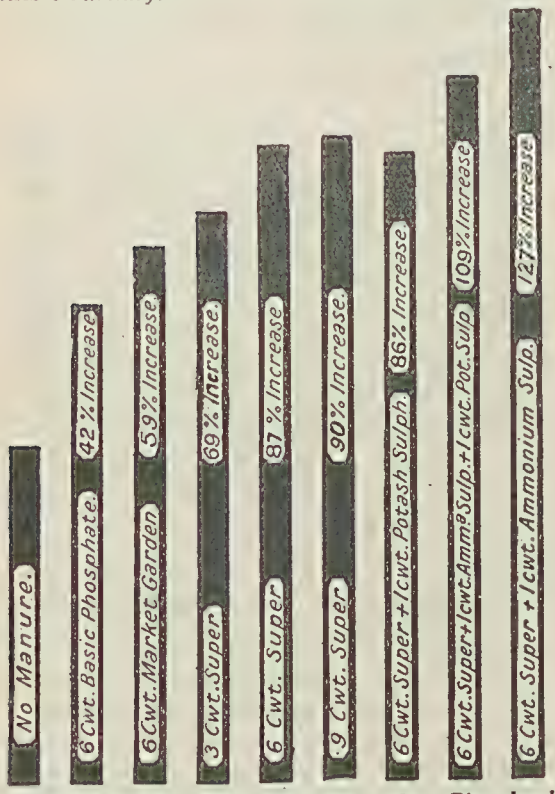
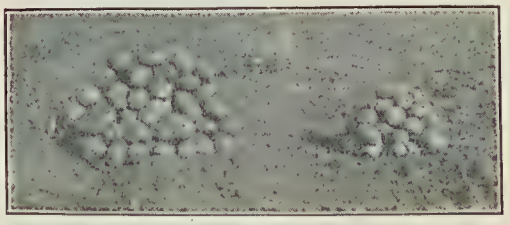

No Manure.
6 Cwt. Basic Phosphate.
42 % Increase
6 Cwt. Market Garden
59 % Increase
3 Cwt. Super
69 % Increase
6 Cwt. Super
87 % Increase
9 Cwt. Super
90 % Increase
6 Cwt. Super + 1 cwt. Potash Sulph.
86% Increase
6 Cwt. Super + 1 cwt. Amm.a Sulp. + 1 cwt. Pot. Sulp
109% Increase
6 Cwt. Super + 1 cwt. Ammonium Sulp.
127% Increase

Fig. 1.—Showing average results at four Gippsland centres—Childers, Fish Creek, Catani, and Korumburra over the period 1923-24 to 1931-32.

Volcanic Soils.

Though, taken as a whole, the increases from manures on volcanic soils are not so spectacular as are those obtained in Gippsland and Beech Forest, they are nevertheless substantial and significant. On the volcanic soils the superphosphate and ammonia mixture has been easily the most profitable fertilizer, giving, over a range of nearly 30 tests, an average increase of 68 per cent. over the return from no manure. The increased values obtained on the volcanic soil crops as a result of manuring are not so striking as in the case of Gippsland crops, but the much higher land values obtaining in the volcanic soil districts make it imperative that land-owners there should obtain maximum possible returns. Considering the great fertility of this class of land it is remarkable that it



Produce from 1-chain rows. Left, Beech Forest selected seed; right, unselected seed.

should respond to artificial fertilizers as well as it does. The average yields obtained in the tests on volcanic soils at seven centres are shown in Table II.

TABLE II.—POTATO MANURIAL TRIALS.

Average Results on Volcanic Soils at Romsey, Wheatsheaf, Musk, Millbrook, Koroit, Illowa, and Trentham East, 1923-24 to 1931-32.

Manure per Acre.	Average Yield.	Number of Tests.	Average Increase.
	T. C.		%
Super., 2 cwt.	5 2	29	36
Super., 3 cwt.	5 10	29	44
Super., 4 cwt.	5 10	29	44
No manure	3 15	29	..
Super., 3 cwt., amm. sulp., 1 cwt.	6 6	29	68
Super., 3 cwt., amm. sulp., 1 cwt., pot. sulp. 1 cwt.	6 5	24	50
Market garden, 3 cwt. ..	5 5	29	40
Basic phos., 3 cwt. ..	4 15	29	26

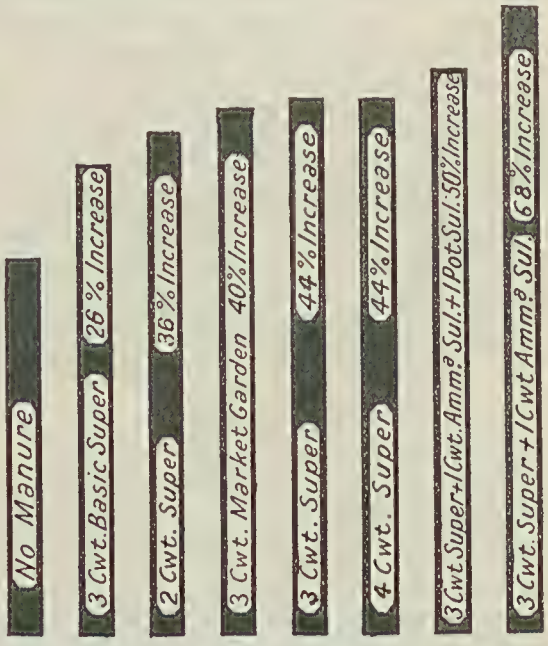
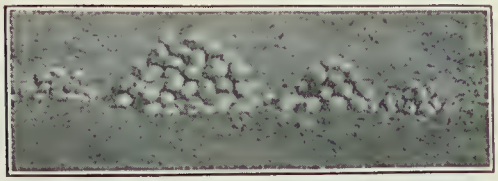


Fig. 2.—Showing average results at seven volcanic soil districts (see Table II.) over the period 1923-24 to 1931-32.



Produce from 1-chain rows. From left—1, unmanured; 2, selected seed, 3 cwt. super; 3, Virus affected seed, 3 cwt. super.; 4, Virus affected seed, unmanured

In Table III. an interesting comparison is made between the natural productiveness of various district soils and their response to manures. The period over which these results were obtained at each centre is shown also. This comparison of the yields from the various potato-growing districts is presented without any comment, except to point out that it is obvious that, on all Victorian soils, no matter how fertile they may be, manuring of some kind is absolutely necessary if maximum yields are to be obtained.

TABLE III.—COMPARATIVE AVERAGE YIELDS SHOWING EFFECTS OF FERTILIZER APPLICATIONS IN THIRTEEN DISTRICTS IN VICTORIA.

District.	Years.	No Manure.	Super. and Ammonia.	Percentage Increase.
		T. C.	T. C.	%
Beech Forest ..	1	4 11	10 15	136
Childers ..	9	2 6	6 0	160
Catani	6	2 7	5 17	150
Fish Creek ..	4	4 16	7 12	58
Koroit	3	4 16	6 16	41
Korumburra ..	5	5 2	10 12	107
Illowa	4	6 5	9 7	50
Millbrook ..	5	2 3	4 15	121
Musk	4	3 3	5 4	64
Romsey.. ..	4	4 13	6 5	34
Trentham ..	5	3 0	6 12	120
Wheatsheaf ..	4	3 1	5 12	83
Warragul* ..	6	4 3	9 9	127

* In the case of Warragul the manure used was super. and potash.

Packing of Citrus Fruit

(*Continued from page 535*).

the grower had to resort to the damaging practice of shaking his oranges up and down in a bag of sawdust to clean them.

STANDARD COUNTS FOR ORANGES IN THE "DUMP" CASE (18 x $8\frac{2}{3}$ INCHES x $14\frac{1}{4}$ INCHES).

(*Local Market Only.*)

Size.	Pack.	Layer.	Layers.	Total.	Remarks.
$2\frac{1}{4}''$	3–2	6 x 5	9	248	Small (smallest $2\frac{1}{4}''$)
$2\frac{3}{8}''$	3–2	6 x 5	8	220	Seldom used
$2^{7}/_{16}$	3–2	5 x 5	8	200	Large (almost $2\frac{1}{2}''$)
$2^{9}/_{16}''$	2–2	7 x 6	7	182	Is a medium-sized $2\frac{1}{2}''$
$2^{11}/_{16}''$	2–2	6 x 6	7	168	Large (almost $2\frac{3}{4}''$)
$2\frac{3}{4}''$	2–2	6 x 5	7	154	
$2\frac{7}{8}''$	2–2	5 x 5	7	140	
$3''$	2–2	5 x 4	7	126	
$3\frac{1}{8}''$	2–2	4 x 4	7	112	
$3\frac{1}{4}''$	2–2	4 x 4	6	96	Smallest $3\frac{1}{4}$
$3\frac{3}{8}''$	2–2	4 x 3	6	84	
$3\frac{1}{2}''$	2–1	5 x 5	5	75	
$3\frac{5}{8}''$	2–1	5 x 4	5	68	
$3\frac{3}{4}''$	2–1	4 x 4	5	60	
$3\frac{7}{8}''$	2–1	4 x 3	5	53	

SPECIAL NOTE.—Actual measurements of the fruit in many packing experiments prove that the 200 count is $2^{7}/_{16}''$ in diameter, and not $2\frac{3}{8}''$ as originally supposed. In addition, the 182 count is not $2\frac{1}{2}''$, but $2^{9}/_{16}''$, and the 168 count $2^{11}/_{16}''$, instead of $2\frac{3}{4}''$.

The other counts graduate exactly in eighths of an inch, as shown on the chart.

STANDARD COUNTS FOR GRAPEFRUIT IN THE "DUMP" CASE (18 x $8\frac{2}{3}$ INCHES x $14\frac{1}{4}$ INCHES).

Approx. Size.	Pack.	Layer.	Layers.	Total.	Remarks.
$3''$	2–2	5 x 4	7	126	Cheeks to side of case like oranges
$3\frac{1}{8}''$	2–2	4 x 4	7	112	Stylar end to side of case
$3\frac{1}{4}''$	2–2	4 x 4	6	96	Stylar end to side of the case
$3\frac{3}{8}''$	2–1	6 x 5	5	83	Cheeks to side of case like oranges
$3\frac{1}{2}''$ $3\frac{5}{8}''$	2–1	5 x 5	5	75	Cheeks to side of case like oranges
$3\frac{3}{4}''$	2–1	5 x 4	5	68	Stylar end to side of case
$3\frac{7}{8}''$	2–1	4 x 4	5	60	Stylar end to side of case
$4''$ $4\frac{1}{8}''$	2–1	4 x 3	5	53	Stylar end to side of case
$4\frac{1}{4}''$ $4\frac{3}{8}''$	2–1	3 x 3	5	45	Stylar end to side of case
$4\frac{1}{2}''$	2–1	3 x 2	5	38	Stylar end to side of case. Pack loosely

NOTE.—In order to maintain the maximum size that will fill the cases properly with each count, it is very important that the fruit in each of the packs be placed according to the manner set out in the "Remarks" column. If this is not adhered to, the grapefruit will not come to the desired height in the case when the packing is finished.

Coccidiosis in the Fowl

By H. E. Albiston, D.V.Sc., Veterinary Research Institute, University of Melbourne.

COCCIDIOSIS is primarily a disease of the intestinal tract, although in chickens the liver occasionally may be affected, and geese sometimes show signs of the disease in the kidneys. The disease has been found also in ducks, turkeys, and pigeons. From a practical point of view, however, Coccidiosis is most important when it occurs among chickens.

The majority of the minute microscopic organisms associated with the causation of infectious disease belong to two main classes, namely, the *bacteria* and the *protozoa*. The bacteria represent the lowliest forms of plant life; the protozoa, on the other hand, are generally regarded as the lowest forms of animal life. Microscopic in size, they have bodies consisting of a single cell, and they frequently exhibit a complicated life cycle, or process of reproduction. To the group of protozoa belong the Coccidia, which cause the disease known as Coccidiosis.

All birds, whether wild or domesticated, may contract Coccidiosis if exposed to infection. As with many other diseases, the ravages of Coccidiosis become more serious when it appears among birds kept in confinement. Geese, turkeys, and ducks on free range are rarely affected in large numbers, although an occasional isolated case may occur from time to time. When Coccidiosis makes its appearance among birds kept in close confinement, the result is generally very serious, and the disease frequently assumes enzootic proportions.

Coccidiosis is most serious when it occurs among young birds. Growing chickens are particularly susceptible to infection, but as maturity is approached, a considerable degree of natural resistance is manifested.

It is only when adult birds become grossly infected, or their resistance weakened through some other cause, that they suffer from Coccidiosis. In fact, mature fowls frequently may be found harbouring coccidia in their alimentary canal without showing any ill effects. Such birds, however, may provide the infective material for a serious outbreak among chickens kept on the same property.

The Parasite and its Life History.

When viewed under the microscope, the coccidia, in the state of development occurring in the droppings of infected birds, are found to be minute bodies, with an ovoid or round shape, and possessing a thick double shell. These egg-like structures are known as *Oöcysts*, which contain within their shells four small structures known as *sporozoites*. The *Oöcysts* possess a marked degree of resistance to adverse conditions.

Coccidiosis is spread by healthy birds taking in these *Oöcysts* with their food and water; that is, infected droppings with which fowl-runs have been contaminated are the means by which the disease is spread from bird to bird.

When the *Oöcysts* reach the intestinal tract, the *sporozoites* which they contain are liberated; the liberated *sporozoites* then penetrate and destroy the cells lining the mucous membrane of the gut. Each *sporozoite* entering a cell begins to multiply rapidly, and the progeny invade further cells so that, in an intense infestation, the destruction of the lining of the bowel becomes extensive. After a certain time, the quick division ceases, and the young coccidia become differentiated into male and female forms; the females are fertilized by the males, and the result of this sexual conjugation is the production of *Oöcysts*. *The Oöcysts* are cast off from the intestinal lining, are voided with the droppings, and the life history proceeds again in the birds swallowing the *Oöcysts*.

Symptoms.

Chickens infected with Coccidiosis may present signs of infection from the tenth day onwards, although, as a general rule, the disease appears after the fourth week. The course is more rapid in very young chickens, with usually a high mortality. The main symptom shown is diarrhoea, with the passage of whitish fluid droppings, which may be streaked with blood. Infected birds become weakened and dejected, with drooping wings and ruffled

feathers; the appetite generally is seriously impaired, or may be absent. Death takes place in a day or two after the appearance of symptoms, although older chickens may live for several days to a week or more before death ensues.

In grown fowls the disease is usually more chronic, with the development of a progressive emaciation and anaemia. The appetite may remain normal, but in the intervals between regular feeding, they show no inclination to scratch for food. Affected birds may live for three weeks after the first signs of the disease are noted. Death frequently occurs quite suddenly.

Post-mortem Findings.

The chief abnormality present consists of a distension of the blind gut or caeca with blood-streaked semi-solid material. Frequently, apart from an anaemic condition of the body, and a moderate distension of the caeca, no typical naked-eye characteristics can be found. It is necessary to stress the fact that it is generally impossible to make an accurate diagnosis without a microscopic examination of the contents or the lining membrane of the bowel. When very young chickens are attacked, it is necessary to make a differentiation between Coccidiosis and Pullorum disease; this is only possible by laboratory investigations.

Methods of Transmission.

The chief ways in which the disease is spread are as follow:—

1. From apparently healthy but mildly infected birds. The presence of birds harbouring Coccidia in their bowel always constitutes a menace to growing chickens. The infective *Oöcysts* present in the droppings may be carried on the boots and clothes of the attendant from the adult birds to the brooder houses and chicken runs.

2. Sparrows and other wild birds may carry the disease from place to place, either mechanically or through their own infected droppings.

3. Chickens may be reared in infected coops, or on ground previously contaminated by infected birds, or they may be transported in crates soiled with infected material.

4. It is sometimes difficult to explain an outbreak of Coccidiosis in very young chickens which have been hatched and reared in new equipment. Such outbreaks may be due to using eggs for hatching which have been laid by infected hens and soiled with droppings containing the *Oöcysts* of coccidia. When the chicken emerges, it picks up the infective material by pecking at the egg shell, becomes infected with Coccidiosis, and transmits the infection to the other chickens. The appearance of Coccidiosis as early as the tenth day after hatching may be explained in this way.

Chick suffering from Coccidiosis.
[From *U.S. Dept. of Agric. Farmers' Bulletin No.* 1652.]

Control.

A study of the life history of Coccidia shows that no control measures can be effective against Coccidiosis unless the strictest attention be paid to the sanitation of chicken houses and runs. There must be no contamination of food and water with infective droppings. One of the most effective means for guarding against contamination is the use of raised wire-mesh floors in the brooder houses. The wire should be placed several inches above the permanent floor, so that the droppings will fall through, and thus minimize the chance of food contamination. Failing this, daily cleansing is essential to prevent the Coccidia which are passed in the droppings from developing to the infective stage. A period of at least 48 hours is required for this development.

Where floors are constructed of concrete, brick, or other non-inflammable material, the most efficient disinfection can be accomplished with a painter's blow-lamp. Boiling water liberally applied will also destroy Coccidia

quickly. Disinfectants may at times be effective, but, having regard to the resistance of Coccidia, little reliance should be placed on chemical preparations.

Direct sunlight and dryness also militate against the development of Coccidia.

Runs to which diseased birds have access are highly dangerous, and should be abandoned for at least a year. Where this is impossible, the soil should be treated with ground quicklime, and ploughed or dug under.

Once the diagnosis of Coccidiosis is established, all obviously sick birds should be killed, and their carcasses, together with those of birds dying from the disease, burnt.

All infected droppings should be burnt to prevent their distribution to other parts of the farm or to other properties.

The ideal procedure would be for one person to undertake the feeding and general management of the infected stock, and to have nothing to do with the remainder of the poultry farm. Where this is impracticable, the infected stock should be fed last, and the attendant should thoroughly cleanse his hands, boots, &c., before leaving the infected premises. Cases are known in which infection was distributed by the boots of attendants.

Until quite recently no remedy could be suggested. Last year, however, the Veterinary Adviser to the Harper Adams Agricultural College, England, published the details of a system of treatment which is said to exert a very beneficial influence on the course of Coccidiosis, provided care is taken to supplement it with sanitary measures. Up to the present time, insufficient data have been accumulated in Victoria on the efficacy of the remedy to enable an authoritative opinion to be given, but, in view of the claims made in England, it is worthy of trial.

A stock solution is prepared as follows:—

Iodine sublimate	1 part
Potassium iodide	2 parts
Water	50 parts.

One part of the solution is added to five parts of fresh or skim milk, and the mixture heated gently until it becomes white. The temperature should not exceed 70 degrees C. The milk-iodine mixture is then added to the drinking water in the proportion of 1 pint to the gallon, and plenty of this water should be available at all times.

Only sufficient solution for one day's supply should be prepared, as the mixture will not keep fresh for any length of time.

Tobacco Growing *(continued from page 537).*

stressed in recent issues of this *Journal*, but it is felt that a further note of warning would be timely. It is safe to assert that the bulk of the tobacco handled and baled during the past season contained an undue percentage of moisture. Growers are urged to examine their bales or bulks carefully for signs of mould. Probably 90 per cent. of growers, who have tobacco stored on their property, will find some evidence of mould in their bulks, unless they have taken precautions to check its development. When tobacco acquires a mouldy smell, its market value is almost destroyed. Any mouldy leaf should be removed from the bale or bulk, and leaf at all moist dried out to a safe condition. This is such that the leaf is just moist enough to handle without breaking.

A uniform strike—the result of careful work.

Orchard and Garden Notes

By Edward E. Pescott, F.L.S.

Frau Karl Druschki.

The Flower Garden.

THE rose is the all-important flower this month. Soil conditions should be studied; and, as far as possible, an endeavour made to keep the roots cool. This may be done either by stirring the surface well, or by mulching with grass or stable manure.

Give each bush a thorough searching, and rub off buds or growths that are growing out and interfering with better placed shoots. Keep a look-out for caterpillars; if not abundant, they may be readily crushed; if present in numbers, spray the bushes with arsenate of lead. If aphis be noticed, spray regularly with nioctine sulphate. If both caterpillars and aphis are present, either mix the two sprays mentioned, or use a white oil instead. Mildew, which appears as a grey powdery covering on the young shoot and leaves should be treated at once, with a powdered sulphur dusting. All withered blooms should be cut off to allow new flowering growths to come.

As soon as the foliage has died down, bulbs of Hyacinths, Tulips, Anemone, and Ranunculus should be lifted, dried, and dusted with lime, and stored in a dry place. Once every third or fourth year is often enough to lift Narcissus bulbs.

The Vegetable Garden.

Seeds of French beans of all kinds may be sown for the main crop. Lime should be sprinkled over them before they are covered with soil. During dry weather, the beds should be well watered, especially during the germination period, to prevent soil caking and to assist the ready development of the seedlings.

This is one of the best times to sow seeds of cucumber and gherkin. The soil should be as rich as it is possible to make it, and the plants ought to be well watered as soon as they appear.

The Orchard.

Strict attention must be paid to spraying for Codling Moth. In view of the possible heavy crop of apples and pears, the spraying must be both thorough and constant in order that a clean crop may be ensured. The later oil-arsenate sprays should not be neglected, and all fallen fruit must be destroyed to prevent any future infection.

Orchardists should examine the trees for San José scale; if present at this time of year, it will quickly spread to the fruit, and scale-infested fruit can neither be sold nor exported. To rid the trees of scale they should be sprayed in summer with an oil spray which will not injure the fruit and the foliage. Dormant season sprays, such as lime, sulphur, and red oil, must be avoided. Spraying at any time should be done when the trees are dry.

Professional Papers

[This section is devoted to professional papers and articles of a scientific character.]

Heredity and Milking Function

The Inheritance of Milk and Butter-fat in Red Poll Cattle

By A. C. T. Hewitt, M.Ag.Sc., Dairy Herd Manager, State Research Farm, Werribee.

THIS study is a continuation of the investigations of Professor Agar, Professor of Zoology, University of Melbourne, entitled, "Heredity and Milking Function," which appeared in the *Journal of Agriculture of Victoria,* in January, 1926; and deals with the inheritance of milk, butter-fat percentage, and butter-fat in the Victoria stud of Red Poll cattle owned by the Department of Agriculture of Victoria, at the State Research Farm, Werribee. The milk and butter-fat records used in these investigations are the 273 day records performed under the regulations governing the Victorian Government Pure-bred Herd Test, published annually, and included in the successive volumes of the Red Poll Herd Book of Australia. They cover the period since the establishment of the Government Herd Test, 1912-13 to 1931-32.

Owing to the fact that a cow's production increases with age up to a certain stage, and then decreases slightly, all records had to be corrected for age, so as to have them on a comparable basis, and these corrected records have been used throughout. To correct a cow's performance for age, correction factors are required. To obtain these factors the production at six years old has been regarded as unity, and the corrected records are in terms of production at that age.

Table I. sets out the correction factors, together with the average production of 217 cows, varying in age from 2 to 14 years. These 217 cows have 538 records between them.

From Table I., it will be noticed that production increases up to the age of six years, and then shows very little variation for the ages of six, seven, and eight years. After eight years, production begins to decrease. Owing to the comparatively small number of cows that have been tested at ten years old or over, the decrease of yield with age is rather irregular, and the records of cows ten years old or over therefore have not been considered. The cor-

TABLE I.—CHANGE IN PRODUCTION WITH AGE (AVERAGE FOR 217 COWS).

Age in Years.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Butter-fat (lb.) ..	262	290	331	335	364	358	365	361	334	343	352	358	294
Correction Factor ..	1·40	1·26	1·11	1·09	1·00	1·02	1·00	1·02	1·10	1·07	1·04	1·02	1·24
Milk (lb.)	6,011	6,662	7,538	7,818	8,590	8,604	8,439	8,410	8,009	7,878	7,690	8,551	7,031
Correction Factor ..	1·43	1·29	1·14	1·09	1·00	1·00	1·02	1·02	1·07	1·08	1·12	1·00	1·23
Butter-fat percentage	4·40	4·39	4·40	4·26	4·25	4·19	4·31	4·29	4·17	4·36	4·61	4·61	4·18

A group of Werribee Red Polls, showing the hind-quarter development. The herd sire, Dominion Bright Belgian is in the centre.

rection factors show close resemblance to those obtained by Professor Agar, who dealt with the records of 98 cows only.

The butter-fat percentage or "test" of cows varies only very slightly, and then somewhat irregularly, with age. It is, therefore, generally considered unnecessary to correct butter-fat percentage for age. Nevertheless, the writer corrected for age, and obtained almost identical results, indicating that the procedure of correction for age is not warranted.

The genetics of farm animals is a very complex study, and modern geneticists still find that the correlation method of studying the inheritance of characters is the simplest. Correlations show the degree of resemblance between parent or offspring, or other relatives in respect to certain characters. If the correlation coefficient is 1 then there is perfect resemblance between the groups of individuals under consideration in respect to the character or trait that is being studied, and if the correlation coefficient is 0, then there is no resemblance whatever. When working with large numbers (over 1,000) of animals that are existing under similar environmental conditions, the correlation coefficients, between parent and offspring, for such characters as milk yield, butter-fat percentage, and butter-fat, &c., are approximately 0.5.* In this investigation, correlation coefficients of approximately 0.35 have been obtained, which are regarded as being very satisfactory for three reasons, namely, (1) the moderate number of animals that it has been possible to work with; (2) the breed is a dual purpose breed; and (3) the changes that have occurred in the stud during the twenty years that the cows have been under test. These changes relate to improved pasturage conditions, and to rigid culling which has eliminated those cows which were neither producing highly themselves, nor breeding "true to production."

The means (M), standard deviations (σ), and correlation coefficients (r) between mothers and daughters in respect to total milk yield, butter-fat percentage, and total butter-fat have been worked out, and are tabulated in Table II.

Table III. is the correlation surface for 155 pairs of mothers and daughters in respect to butter-fat percentage. Having obtained the standard deviations and the correlation coefficient, what is known as the "Regression Coeffi-

Table II.—Means, Standard Deviations, and Correlation Coefficients.

	Milk.			Butter-fat Percentage.			Butter-fat.		
	M lb.	σ lb.	r	M %	σ %		M lb.	σ lb.	r
Mothers	8,550	1,330	0·321 ±0·049	4·38	0·42	0·388 ±0·046	368	56	0·316 ±0·049
Daughters	8,650	1,765		4·39	0·40		372	65	

cient" can be worked out. In this case the regression coefficient $= \frac{0{\cdot}388 \times 0{\cdot}40}{42} = 0{\cdot}370$, and by its use the expected test of the daughter can be arrived at, when the test of the mother is known. The daughters on the average will have 0.370 times the deviation of their mothers. If a mother has a test of 4.80, then she has a deviation of 0.42 points from the mean of all others, which is 4.38. Now the expected deviation in test for a daughter of such a mother will be $0.370 \times 0.42 = 0.16$ points from the mean of all daughters, which is 4.39. Therefore the expected test of the daughter will be $4.39 + 0.16 = 4.55$. By similar calculation the expected test of daughters of other mothers may be arrived at.

Mothers testing above the average are expected to have daughters testing above the average, and this will be the case if a number of daughters are considered, although individual daughters may vary considerably; but daughters generally will only be 0.370 times as much above the average of all daughters as the mothers are above the average of all mothers; and similarly mothers testing below the average will have daughters testing below the average, but only 0.370 times as far below the average of all daughters as the mothers are below the average of all mothers.

It is thus seen that a daughter does inherit some of the factors that contribute in the formation of the character known as butter-fat percentage, or test from its mother or dam. The remainder of these factors are inherited from the sire and other ancestors, who have transmitted these factors, as recessive factors through the parents, to the offspring where they are now appearing.

Tables IV. and V. are the correlation surfaces for total milk yield and total butter-fat respectively between 155 pairs of mothers and daughters.

Total milk yield and butter-fat are influenced more by environmental conditions as distinguished from hereditary factors than is butter-fat percentage; and greater fluctuations with less correlation between mothers and daughters may be expected in these respects.

It will be noticed that the correlation coefficients for both milk yield and butter-fat between mothers and daughters are lower than is the correlation coefficient for butter-fat percentage.

The correlation coefficients for milk yield, butter-fat and butter-fat percentage are all greater now than when Professor Agar made

TABLE III.—CORRELATION SURFACE OF BUTTER-FAT PERCENTAGE OF MOTHERS WITH THAT OF DAUGHTERS.

Mothers.

Daughters. %	3·5 to 3·6.	3·6 to 3·7.	3·7 to 3·8.	3·8 to 3·9.	3·9 to 4·0.	4·0 to 4·1.	4·1 to 4·2.	4·2 to 4·3.	4·3 to 4·4.	4·4 to 4·5.	4·5 to 4·6.	4·6 to 4·7.	4·7 to 4·8.	4·8 to 4·9.	4·9 to 5·0.	5·0 to 5·1.	5·1 to 5·2.	5·2 to 5·3.	5·3 to 5·4.	5·4 to 5·5.	5·5 to 5·6.	
3·5–3·6	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
3·6–3·7	2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3
3·7–3·8	..	..	..	..	..	3	..	2	1	..	..	..	..	..	..	..	..	..	..	..	..	6
3·8–3·9	1	..	..	..	..	1	..	..	..	1	..	..	..	1	..	..	..	..	..	..	..	4
3·9–4·0	..	..	..	..	1	1	2	..	1	1	1	..	1	..	..	..	..	..	..	..	..	8
4·0–4·1	..	..	1	1	..	1	2	1	2	..	..	1	..	1	..	..	..	..	..	..	..	10
4·1–4·2	..	..	..	1	..	1	4	3	2	1	..	3	1	1	..	..	..	..	..	..	..	17
4·2–4·3	1	..	..	..	..	2	1	2	..	2	1	1	1	1	..	..	..	1	..	..	1	14
4·3–4·4	..	..	2	1	..	3	2	3	4	..	2	1	..	..	..	..	..	..	1	..	1	20
4·4–4·5	..	..	..	..	..	1	2	2	2	1	2	..	1	1	..	..	..	..	..	..	..	12
4·5–4·6	..	..	..	2	..	3	1	2	2	1	1	..	6	1	..	..	..	..	..	..	..	19
4·6–4·7	..	..	..	..	..	..	1	1	1	..	1	1	1	1	..	..	..	..	..	..	..	7
4·7–4·8	..	..	1	1	1	2	..	1	1	3	1	..	..	..	..	..	..	..	..	..	..	11
4·8–4·9	..	..	..	..	..	..	..	..	..	..	1	..	1	2	..	..	..	..	..	..		6
4·9–5·0	..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	3
5·0–5·1	..	..	1	..	..	..	..	..	..	..	1	..	..	..	1	..	..	..	..	..	..	3
5·1–5·2	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	2
5·2–5·3	..	..	..	..	..	..	..	..	2	..	..	..	..	1	..	..	..	2	..	..	..	5
5·3–5·4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		2
5·4–5·5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5·5–5·6	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	1
	4	..	6	6	3	19	16	18	20	11	11	7	13	10	1	..	..	3	1	..	6	155

* Refer to Milk "Secretion," by J. W. Gowen. Baltimore: Williams Wilkins Co., 1924.

the original investigation on the "Victoria" herd. The variability in respect to milk yield and total butter-fat is greater in the case of mothers than in the case of daughters; whereas in respect to butter-fat percentage, the daughters are the more variable.

The Influence of the Bull.

By the use of the results set out in the preceding tables, it is possible to determine which bulls are increasing production in the herd, and which are not, and in Table VI. the performances of the bulls used in the herd under consideration are tabulated.

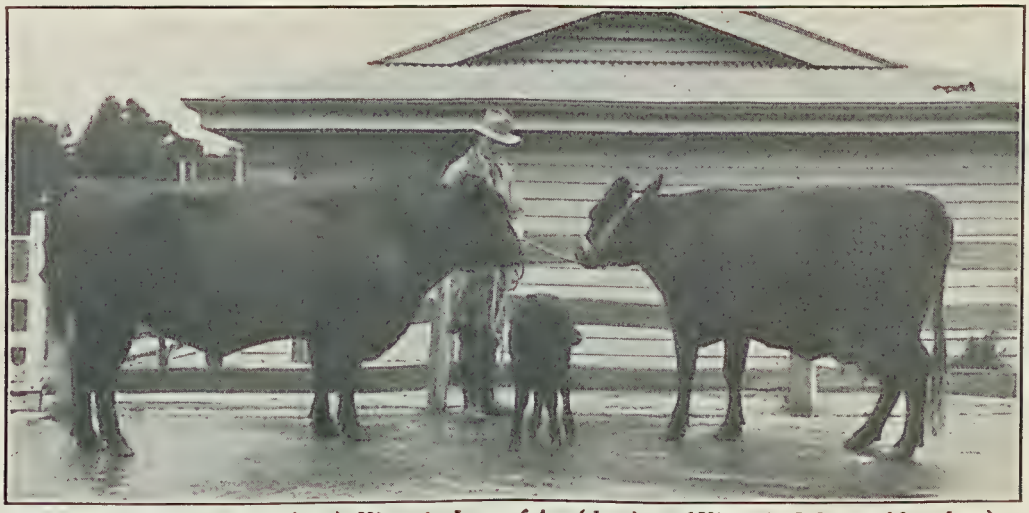
The case of Belligerent may be cited to explain this table. He has 38 tested daughters from tested mothers, and 12 of these have produced more milk than was expected of them after allowing for the influence of the mothers; 13 have produced as much milk as was expected, while 14 have produced less milk than

TABLE IV.—CORRELATION SURFACE OF TOTAL MILK YIELD OF MOTHERS WITH THAT OF DAUGHTERS.

Daughters. Lb.	Mothers. 5,000.	5,500.	6,000.	6,500.	7,000.	7,500.	8,000.	8,500	9,000.	9,500.	10,000.	10,500.	11,000.	11,500.	12,000.	12,500.	13,000.	13,500.	—
5,000	..	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	2
5,500	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	2
6,000	..	..	1	1	1	..	..	1	..	..	..	..	..	..	..	..	..	..	4
6,500	..	..	..	1	1	1	3	1	1	1	..	..	..	..	..	..	..	..	9
7,000	..	..	..	1	..	..	2	1	3	..	2	..	..	..	..	..	..	..	9
7,500	..	..	..	1	1	4	3	4	1	..	2	..	1	..	..	..	..	..	17
8,000	1	1	..	1	2	5	1	1	4	..	3	..	..	2	1	..	..	..	22
8,500	..	..	..	..	3	4	2	3	2	1	1	..	..	..	..	..	..	..	16
9,000	..	..	2	1	1	1	7	7	3	3	..	..	..	..	1	..	..	..	26
9,500	..	..	..	2	..	2	2	5	1	..	2	..	..	1	..	..	..	1	16
10,000	..	..	..	..	2	1	2	2	..	..	2	..	..	..	1	..	..	..	10
10,500	..	..	..	..	..	..	..	1	..	1	1	..	..	..	1	..	..	..	4
11,000	..	..	..	..	..	..	1	1	2	1	1	..	..	..	..	..	..	..	6
11,500	..	..	..	..	..	..	1	1	1	2	..	..	..	..	..	..	..	..	5
12,000	..	..	..	..	..	..	..	..	1	1	1	..	1	1	..	..	..	1	6
12,500	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
13,000	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
13,500	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1
	1	1	3	9	11	18	24	30	20	10	15	1	2	4	4	..	..	2	155

TABLE V.—THE CORRELATION SURFACE OF TOTAL BUTTER-FAT OF MOTHERS WITH THAT OF DAUGHTERS.

Daughters. Lb.	Mothers. 225.	250.	275.	300.	325.	350.	375.	400.	425.	450.	475.	500.	525.	550.	
225	..	..	1	..	..	..	..	..	..	..	..	..	..	..	1
250	..	..	..	..	1	2	..	..	..	..	..	..	..	..	3
275	..	..	1	2	4	1	4	2	..	..	1	..	..	..	15
300	..	1	1	1	..	5	1	..	..	1	..	..	..	..	11
325	..	..	2	..	5	2	3	..	1	..	2	..	..	1	16
350	..	1	..	6	3	6	6	2	3	..	..	..	..	..	27
375	..	..	1	2	4	8	2	..	2	2	..	..	..	..	21
400	..	..	2	2	2	5	6	1	2	..	1	1	..	..	22
425	..	..	..	..	1	2	4	..	..	2	1	..	..	..	10
450	..	..	..	..	1	..	4	1	2	..	1	1	..	..	10
475	..	..	..	..	1	1	4	1	3	1	..	..	..	..	11
500	..	..	..	..	1	..	1	1	1	3	1	..	..	..	8
525	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	..	2	8	13	23	32	35	8	14	9	7	3	..	1	155



Dominion Bright Belgian (sire), Victoria Joan of Arc (dam), and Victoria Johanna (daughter).

was expected of them. The average production of these 39 daughters was 60 lb. more milk than was expected; and similarly the columns for butter-fat percentage and butter-fat can be explained.

Summarizing the performance of these bulls, it is found that:—

Belligerent raised both milk and butter-fat slightly, but the milk less than the butter-fat, hence he raised the test slightly.

Nicotine raised both milk and butter-fat, but the milk more than the butter-fat, hence he lowered the test.

Vice-Regal lowered both milk and butter-fat, but the milk more than the butter-fat, hence he raised the test.

Victoria Bit o'Bacca lowered both milk and butter-fat, but the milk more than the butter-fat, hence he raised the test.

Longford Major lowered both milk and butter-fat, but the milk less than the butter-fat, hence he lowered the test.

TABLE VI.—INFLUENCE OF THE SIRE ON DAUGHTERS' PRODUCTION.

Sire.	Total.	Milk.				Test—Butter-fat Percentage.				Butter-fat.			
		Number of Daughters.			Mean difference of daughters from expectation (lb.).	Number of Daughters.			Mean difference of daughters from expectation (%).	Number of Daughters.			Mean difference of daughters from expectation (lb.).
		Above expectation.	Equal to expectation.	Below expectation.		Above expectation.	Equal to expectation.	Below expectation.		Above expectation.	Equal to expectation.	Below expectation.	
Belligerent	39	12	13	14	+60	14	17	8	+0·07	11	16	12	+3
Nicotine	38	21	9	8	+590	5	19	14	−0·16	14	16	8	+9
Vice-Regal	35	10	8	16	−510	13	14	8	+0·08	12	6	17	−13
Victoria Bit o'Bacca ..	18	4	3	11	−630	8	8	2	+0·28	5	5	8	−16
Longford Major ..	17	4	5	8	−110	..	6	11	−0·31	4	4	9	−25
Tabacum	9	..	1	8	−1,770	8	1	..	+0·46	1	3	5	−44
Victoria Air Marshal ..	8	6	1	1	+730	4	3	1	+0·11	5	3	..	+39
Victoria Volcano ..	6	4	..	2	+1,220	1	4	1	−0·01	4	2	..	+66
Earl of Beaconsfield ..	4	..	1	3	−960	3	1	..	+0·44	..	4	..	+1
Other Bulls (10) ..	12	7	3	2	+700	1	7	4	−0·16	4	5	3	+10

Cows are counted as "equal to expectation" when they differ from expectation by less than 500 lb. of milk, 25 lb. of butter-fat, and 20 points in test.

Tabacum lowered both milk and butter-fat, but the milk more than the butter-fat, hence he raised the test.

Victoria Air Marshal raised both milk and butter-fat, but the milk less than the fat, hence he raised the test.

Victoria Volcano raised both the milk and butter-fat almost equally, barely altering the test.

Earl of Beaconsfield lowered the milk, and only slightly raised the butter-fat, hence he raised the test.

Victoria Joan of Arc, the highest producer at present in the Werribee herd (sire, Belligerent).

The Influence of the Grandmothers.

No significant correlation for either milk yield, total butter-fat, or butter-fat percentage has been found to exist between the granddaughters and the paternal or maternal grandmothers, due partly to the changing environment, and partly to the heterozygosity of the older members of the stud. Gowen working with the Friesian cattle in the United States of America has found a correlation coefficient of 0.25 for milk and butter-fat percentage between grandmothers and granddaughters.

Most studies on the inheritance of the milking function have been carried out on the purely dairy breeds of cattle, such as Friesian, Jersey, Red Danish, and Ayrshire, and in most cases larger correlation coefficients have been obtained from those in the Red Poll herd under investigation. This was to be expected because Red Poll cattle are essentially a dual-purpose breed, and the breeder has to select and breed for meat production as well as milk and butter-fat production.

The Methods of Breeding.

The data available makes possible a brief study of the various methods of breeding that have been adopted in this stud herd since its foundation. Before presenting such study, however, a short summary of the different methods of breeding customarily adopted by breeders will be advantageous. These methods are illustrated thus:—

1. Crossbreeding.
2. Grading up.
3. Purebreeding { (*a*) Outcrossing. (*b*) Inbreeding { i. Line breeding ii. Closebreeding.

Cross breeding is the mating together of two animals (or plants) belonging to different genera, species, breeds (or varieties). The progeny are known as hybrids or cross-breds, and are noted for their vigour, hardiness, disease resistance, and rapid growth. This phenomenon is known as hererosis. The mule is a well-known example, and is suitable for hard conditions. It can do more work on less feed than either of its parents (the jack—male of the ass family, and the mare—female of the horse family).

In the meat breeds of cattle, swine, sheep, and even poultry, the crossing of distinct breeds is a very common practice. The in-

creased size of the progeny and the rapidity with which the size is obtained, are so outstanding that the method tends to replace pure breeding as far as meat production is concerned.

There is very little scientific data relating to the cross breeding of dairy cattle in Victoria, but the first generation cross between the Friesian and the Jersey is fairly common. It has the combined dairy characteristics, and is in eager demand at dairy cattle sales.

Grading up is the stepping stone to pure breeding, and comprises the practice of using a pure-bred bull or sire on ordinary grade females. If pure-bred sires are continually mated to the progeny, the practice is to be highly commended. The successive progeny will become uniform in appearance, and if the sire is selected judiciously, their production will be increased. After five or six generations the descendants will be, to all intents and purposes, pure-breds.

All pure-bred animals have been graded up either by natural selection, or by man, from the original native stock. Some of the best families in the Red Poll stud under consideration have been graded up from cows of unknown breeding.

Pure breeding is the mating together of animals within a fixed breed.

(*a*) Out-crossing is pure breeding with animals that are unrelated, or that show no relationship for the first six generations back in their pedigrees. It is the most common practice in pure breeding, but it is usually accompanied with success only when the breeder luckily selects a sire that will "nick" with his female stock.

It is really a "hit or miss" system, and when practised generally results in the stud remaining stationary or deteriorating.

(*b*) Inbreeding is pure breeding with related animals. Inbreeding is being adopted more and more, and it leads to an accentuation of characters whether desirable or undesirable. When inbreeding is practised, severe culling has to be adopted during the first few generations while the undesirable characters continue in evidence, and require to be eliminated. Ultimately by this method a homogenous stud or breed is obtained (e.g., the Jersey and Guernsey cattle that have been inbred for two centuries on their respective islands without the addition of any outside blood whatsoever). Intensive inbreeding may lead to loss of vigour and vitality, and this has to be guarded against. Inbred animals, when out-crossed with other strains, usually produce progeny with a predominance of the accentuated desirable characteristics.

As stated above, inbreeding may be subdivided into—

(i) Line breeding, which is inbreeding with more or less distantly, but distinctly related animals.

(ii) Close breeding, which is inbreeding with closely related animals such as parent with progeny, full or half sister with full or half brother, &c.

These three methods of pure breeding have been practised in the herd under mention, and Table VII. illustrates the results obtained from the three different methods. This table is explained similarly to Table VI.

TABLE VII.—INFLUENCE OF THE METHOD OF BREEDING ON DAUGHTER'S PRODUCTION.

Method of Breeding of Daughters.	Total.	Milk.				Test—Butter-fat Percentage.				Butter-fat.			
		Number of Daughters.			Mean difference of daughters from expectation (lb.).	Number of Daughters.			Mean difference of daughters from expectation (%).	Number of Daughters.			Mean difference of daughters from expectation (lb.).
		Above expectation.	Equal to expectation.	Below expectation.		Above expectation.	Equal to expectation.	Below expectation.		Above expectation	Equal to expectation.	Below expectation.	
Outcrossing	97	29	29	39	−4	28	39	30	−0·02	24	40	33	−6
Linebreeding	53	27	8	18	+190	16	26	11	+0·04	23	15	15	+12
Closebreeding	36	12	7	17	−342	12	13	11	+0·07	13	9	14	−10

A synopsis of this table reveals the following results:—

(1) The test or butter-fat percentage is not changed by the method of breeding.

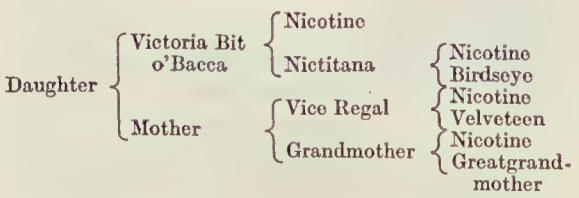
(2) Out-crossing has slightly lowered both milk yield and total butter-fat.

(3) Line breeding has increased both milk and butter-fat yields.

(4) Close breeding has lowered both milk and butter-fat yields.

Line breeding has thus proved to be the most successful breeding method that has been adopted.

A brief description of the methods of close breeding, as applied in this herd, is worthy of note. One instance is exemplified by a cross with Victoria Bit o'Bacca (sire Nicotine), on daughters of Vice-Regal (sire Nicotine), whose mothers were sired by Nicotine. To make this more clear, such a pedigree is elaborated below:—



Eight daughters thus bred have been tested, and no less than six of them have produced less milk, and five less butter-fat, than was expected after making the allowance for the influence of the mothers. These cows are also smaller than the average of the herd.

Daughters whose parents were half brothers and sisters, but with no other blood relationship, have produced slightly more milk and butter-fat than was expected; whereas daughters whose parents were full brothers and sisters, or whose parents were half brothers and sisters, and with other blood relationship, have produced slightly less milk and butter-fat than was expected.

The Red Poll cattle in this stud are still showing heterozygosity (genetic variation) as far as milk yield, butter-fat percentage, and butter-fat are concerned; but nevertheless they are rapidly becoming more and more homozygous (uniform genetically) from year to year.

In conclusion, it may be stated that line breeding and systematic culling of all undesirables are the methods that have to be adopted before a breed or stud will become fixed at a high level of performance.

This investigation has shown that out-crossing gives almost neutral results, but it should be mentioned that most of the out-crossing was done in the earlier history of the stud, before the present high level was obtained, and that out-crossing now probably would lower the performance of the stud considerably. As the better families were segregated out, inbreeding became the more common practice, and the present herd of 127 females (all ages, October, 1932) contains 14 out-crossed, 84 line-bred, and 29 closely-bred females.

Most of the inbreeding has been done with Nicotine blood through the bulls Nicotine, Vice-Regal, Victoria Bit o' Bacca, Victoria Air Marshal, and Victoria Volcano; a fair number of cows are inbred with Longford Major blood through the bulls Longford Major, Victoria Air Marshal, and Earl of Beaconsfield; but the only inbreeding that has been practised with Belligerent blood is where Belligerent has been mated to his own descendants. The present herd sires are Dominion Bright Belgian, who is inbred to Nicotine, Belligerent, and Longford Major; and Victoria Royal Ringer, a son of Vice-Regal, and a grandson of Belligerent.

Rose Diseases and Their Control

By B. J. Grieve, M.Sc. (National Society's Research Scholar; Fred Knight and Wyselaskie Scholar).

XXI.—DIEBACK OF RAMBLER ROSES.

History and Distribution.

THIS disease was first noticed in England in 1921, occurring on rambler roses ("American Pillar," "Lady Gay"). It does not appear to be a very widespread or serious disease in England, and, so far as can be ascertained, it has not been reported from other countries.

Symptoms.

Shoots of the rambler in a late stage of the disease show dead and black, while the leaves on less badly affected shoots turn yellow and fall. There is a definite line of demarcation between healthy and diseased tissue on the shoots; the healthy tissue is separated from the dead by a vivid reddish purple area. This extends for a few inches from the dead greyish portion through the diseased but still living tissue to the healthy green parts. The dead greyish areas invariably bear the remains of one or more dead buds.

Etiology of the Disease.

Dieback of rambler roses is caused by the fungus *Gnomonia Rubi* Rehm. Dowson[1] in 1925 showed that this fungus was the causative agent of the disease. The fungus was originally described by Rehm[3] and named *Gnomonia tetraspora* Wint. var. *Rubi* Rehm. Winter[4] in 1887 changed it to *Gnomonia Rubi* Rehm. The fungus had only been found parasitic on blackberry shoots (Edgerton[2] 1907) prior to being found parasitic on the rose.

Morphology.

Perithecia black, nearly spherical, 300 x 350μ provided with long beaks 700-840μ, which are covered with slightly projecting hyphae, which give them a roughened appearance under the low power of the microscope. Asci colourless, 38-44μ long by 8-10μ at their widest part; 4 large and 2 small ascospores in each ascus; large ascospores 12-14μ long x 2·5-3μ wide; small ascospores 4-9μ long x 2μ wide.

Life History.

The ascospores germinate in the spring and infect the plant through frost-bitten buds. The greatest amount of dieback occurs in the summer, and perithecia develop on the dead shoots.

Control.

Any infected shoots should be cut out and burnt.

Dieback of Rambler Roses—Bibliography.

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4 Winter, G.—Hedwigia, Vol. 26, p. 62, 1887.

XXII.—BRIAR SCAB.

Briar Scab is an epiphytotic disease, and in seasons favorable to the fungus may cause serious damage in a rose garden. According to Massee[3] the fungus exercises much discrimination in the choice of a host. He states, "In one garden, a bed of Soleil D'Or, and another bed of Caroline Testout, about 30 yards apart, had every plant in each bed badly affected, whereas intervening beds showed no sign of the disease."

Wild roses are commonly found affected by this disease.

History and Distribution.

The disease was recognized in Europe as far back as 1829, when the fungus was found occurring on the stems of rose plants and ash trees. Saccardo[5] records its presence in Britain, Germany, Belgium, France, and Italy by 1892. Massee[3] described the disease as being serious in England in 1909. It has not been recorded for the United States of America or for Australia. It has been reported as occurring in Brazil in 1926.

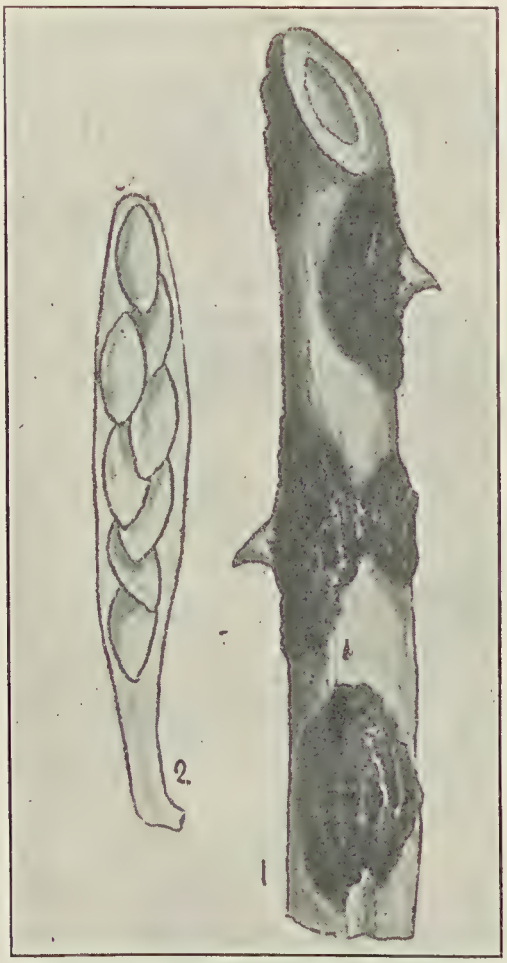

Fig. 23.—Briar Scab (*Botryosphaeria Dothidea*) on wild Rose—(1) Fungus on portion of stem; (2) Ascus containing spores.
(After Massee)

Symptoms.

The presence of the fungus is indicated by large, slightly raised black scabs, which are cracked concentrically, on the bark.

Etiology.

Briar Scab of the rose is caused by the fungus *Botryosphaeria Dothidea* (Moug.) Ces. and De Not. Mougeot[4] in 1829 first described the fungus under the name *Sphaeria Dothidea*. The name was changed by Fries[2] in 1849 to *Dothidea Rosae*, and later renamed *Botryosphaeria Dothidea* by Cesati and De Notaris[1] in 1863.

Morphology.

Perithecia buried in the dark stroma; asci clavate, 8 spored; spores hyaline continuous, 17-20 x 8-9μ.

Minute conidia are contained in cavities in the stroma.

Control.

During the summer care should be taken that the disease is not introduced into the garden on briar stocks. If it occurs on cultivated roses, these should be cut away below the diseased area. Where the scabs extend below the surface of the soil, the plant should be removed and burnt.

Brior Scab. Bibliograhy.

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2. Fries, E.—Summa Veg. Scand., pp. 386 and 402, 1849.
3. Massee, G.—Briar Scab in "Dis. of Cult. Plts. and Trees," pp. 174-5, 1915.
4. Mougeot, J. B.—In Systema Mycol. II., p. 423, 1829.
5. Saccardo, P. A.—Syll. I., p. 460, 1882.

XXIII.—AN INFECTIOUS CHLOROSIS OF ROSE.

This disease appears to be of recent occurrence in the United States of America, being described only in 1927. It is possible that the disease was present for some years before this, but not in noticeable proportions. It affects mainly roses grown under glasshouse conditions, although it has been known to occur on roses in the open, and is of some economic importance in the United States of America. The disease is at present being investigated by pathologists there, and the results of their work up to the present time are summarized below.

Distribution.

This infectious chlorosis, first called "Rose Mosaic," is present in the United States of America, Canada, and British Columbia. It appears to be most serious in the United States of America, having been reported from the eastern, middle, and western parts of the country.

Varieties Affected.

The disease has been found occurring naturally only on H.T.'s and Rosa manetti. It has been reported on Ragged Robin and Pernetiana varieties by Nelson,[1] and has been experimentally transferred to *R. multiflora* by White.[2] The following varieties have shown typical symptoms:—Madame Butterfly, Pre-

mier, Templar, Hadley, Columbia, Etoile de France, Rose Marie, Shot Silk, and Hoosier Beauty.

In all cases this disease is associated with the use of domestic manetti.

Symptoms.

The symptoms, according to White[2] and Nelson,[1] are striking. The plants are usually dwarfed or stunted, and do not respond to forcing. The dwarfing is expressed in all parts of the plant; leaves and leaflets, length of flower stem, size of bloom, vigour of canes, and root development are all directly affected.

Buds are usually malformed and imperfect, and sometimes markedly bleached. Distinct chlorotic areas are evident on the leaves, especially along the midrib. They also occur in the lamina of the leaflet, and frequently at the margin.

Slight necrotic areas occur sometimes in the chlorotic regions. Chlorosis is often limited to one side of a leaflet causing a distortion of the leaf due to unequal growth, while isolated chlorotic areas along the midrib cause the leaflet to pucker or ruffle. The midribs of leaves are often distorted and bent.

Etiology.

This disease comes under the heading of virus diseases; the causative agent is considered to be an ultra-microscopic organism or particle.

The disease has been experimentally transferred from diseased to healthy plants by using buds from diseased plants.

White[2] has transferred the disease by the above method to *Rosa multiflora,* but has failed to transfer it to *Rosa odorata,* and to Pernetiana or Polyantha types.

Juice inoculations have so far proved unsuccessful. White has conducted experiments to determine the insect vector in connexion with the disease, but so far has obtained only negative results. The natural spread of the disease is very slow.

Control.

Growers are advised to grow a resistant stock such as *Rosa odorata,* and clean up their present infected stock of *Rosa manetti* and Ragged Robin by rogueing* their fields.

* Rogueing—destroying any plants which show symptoms of the disease.

The source of bud wood or scion material should be carefully investigated since infected buds or scion wood, even on healthy or resistant stock, will continue to be diseased, and will fail to force, and will not produce a normal and profitable crop.

Infectious Chlorosis of Rose. Bibliography.

1. Nelson, R. — Infectious Chlorosis of Rose. Abstract in Phytopath, Vol. 20. Jan., 1930.
2. White, R. P.—An Infectious Chlorosis of Rose Amer. Rose Annual, pp. 87-90, 1930.
3. ———. An Infectious Chlorosis of Rose Abstract in Phytopath, Vol. 20. Jan., 1930.
4. ———. Infectious Chlorosis of the Rose Nursery Dis. Notes of the N.J. Ag. Exp. Sta., Vol. 11, No. 7. Jan., 1930.

XXIV.—EURYACHORA ROSICOLA
Av. Saccá.

Averna Saccá describes this new fungal disease as being somewhat serious in Brazil in 1926.[1] He states that in one locality a whole nursery was badly attacked.

Fig. 24.—Infectious Chlorosis of Roses. Healthy and diseased plants of Madame Butterfly. Diseased leaf above.
(After R. White)

Symptoms.

Twigs are covered with large marginate livid spots which increase in size extending to the base, and thence to the stem. Later they turn reddish-brown or ashen grey. Longitudinal splits are seen in the bark, and stromata with ascospores are exposed. Affected twigs die back, but suckers are often produced. These, however, do not develop far.

Etiology.

The above condition in roses is brought about by a fungus *Euryachora rosicola* Av. Sacc.

Morphology.

Stromata irregular, pseudo-parenchymatous and dark coloured. Asci claviform short stalked, 94.5–108 x 27μ. Ascospores eight in an ascus, distichous, navicular, 43–45.9 x 18–19μ at first hyaline, then greenish and finally grey.

The affected tissues contain septate branched hyphae, at first hyaline, then grey.

Control.

Cut out and burn affected parts. Spray with Bordeaux mixture (6–4–40).

Bibliography.

1. Averna Saccá, R.—Contrib. to the study of Fgous. Dis. of Roses Sec. da Agric. Comm., e Obras Publicas Sao Paulo, 67, p. 26, 1926.

XXV.—HENDERSONIA ROSICOLA Av. Sacc.

Averna Saccá[1] has reported this new fungal disease of roses from Brazil in 1926. The disease manifests itself on the twigs of recently pruned roses.

Symptoms.

Large regular spots or livid rings are formed, which, increasing in size, spread to the stem and cause wilting. Later the colour becomes darker and abundant fruiting bodies are visible.

Etiology.

The causal fungus is *Hendersonia rosicola* Av. Sacc.

Morphology.

Acervuli globose, lenticular or pyriform, and are immersed in the cortical tissue. Spores hyaline, cylindrical, ovate or elliptical at the apex, ultimately three septate and greenish; 9–13μ long x 13–14.8μ in diameter.

Control.

Averna Saccá recommends the cutting away of affected wood, and burning the prunings.

Bibliography.

1. Averna Saccá, R.—Contributions to the Study of the Fungous Diseases of Roses. Secretaria da Agric Comm. e Obras Publicas Sao Paulo, 67 : p. 26, 1926.

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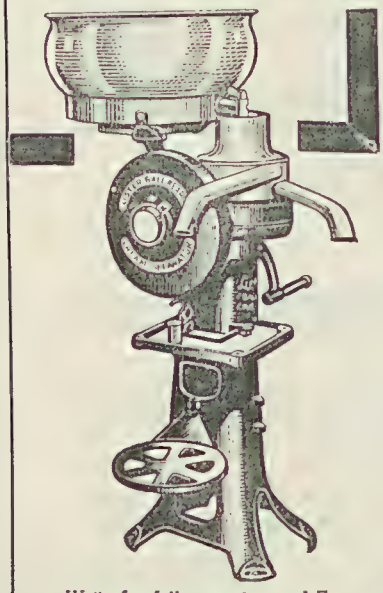

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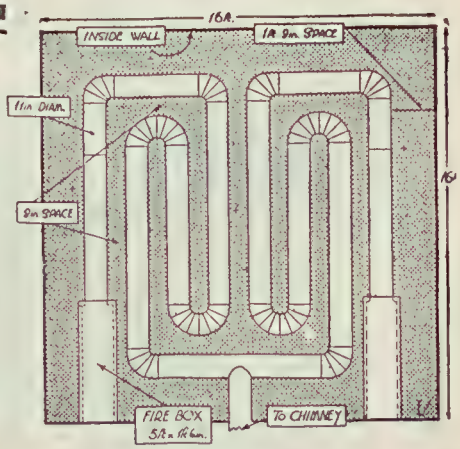

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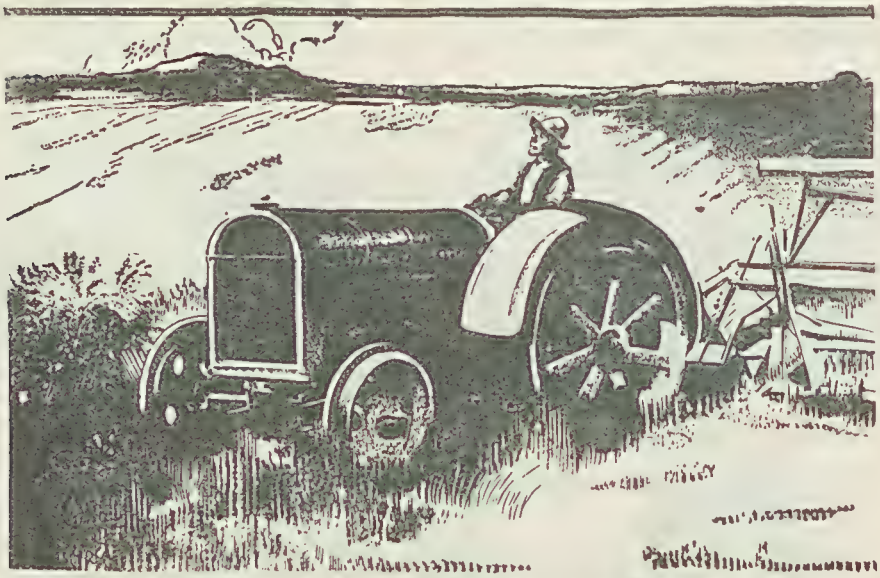

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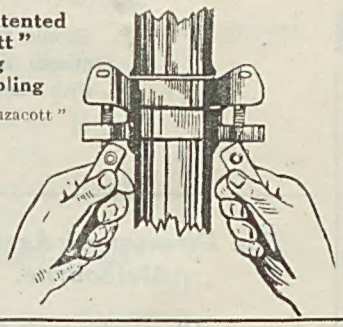

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